FACETING FOR AMATEURS

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Faceting For Amateurs

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TO OUR STUDENTS

They taught us the intricacies of faceting.

Foreword

For the past several years the need for a complete book on faceting has become more and more pressing. A book covering all aspects of the craft, selecting and buying, orienting before cutting, methods of obtaining the largest and most perfect stone from rough material, and the practical ways of using the many different faceting machines on the market has been desired by many faceters. Glenn and Martha Vargas have written such a book; a book with ample detail where needed, with simplified and practical explanations of everything pertaining to this most facinating part of the lapidary hobby.

When I first started to read this book, I thought too many words had been used to explain the subjects. The trouble was that I have faceted several thousand stones, and many of the explanations were unnecessary for me. Then I found myself thinking how much simpler it would have been when I was learning if such a book had been available. I had bought two copies of excellent lapidary books then on the market. They helped a little, but both were far too brief regarding faceting. This book is not brief.

Glenn Vargas is one of the most experienced faceters and teachers of faceting in this country. He has been faceting over twenty years, and he and his wife have been teaching the craft in the California schools for nearly the same period of time. This has given them the ability to put themselves in the beginner's place and word all explanations accordingly.

There is another even more valuable use for this book; one that will be of the greatest service to experienced faceters as well as beginners. The very complete gem tables and facet cutting angle data, notes about the fragility of gem minerals and methods of working them, and types of laps and agents for cutting and polishing, will help all faceters as long as they facet.

Charles J. Parsons, G. G., F. G. A.

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One of the greatest joys of authorship is the finding of willing hands and minds that will unstintingly assist. Without the help of such individuals, a book such as this would be most difficult.

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To all of these people, individually and collectively, go the authors' thanks for any success of this book.

Glenn and Martha Vargas

Thermal, California
June 1, 1969

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Introduction

THE ART OF gem cutting encompasses a wide field of endeavor. Some gems may be produced with very little effort; others may require many hours of tedious work.

One of the newer methods of producing gems, called tumbling, needs only the simple placement of irregular rough chunks of minerals, along with abrasives, into a barrel-like tumbling machine. After various changes of abrasives and the addition of some type of polishing agent, the tumbled stones, sometimes called baroque gems, are ready to fashion into jewelry.

Starting with this very simple gem cutting method, gem cutting processes of varying degrees of intricacy are met with until we reach the carving process. It is almost universally agreed that the carving-in-the-round of precious stones is the highest form of gem cutting.

Between these two extremes lie a number of forms of expression. The cutting of cabochons (dome-shaped stones); intarsia (stone inlay); cameo cutting (low relief carving); intaglio making (negative relief carving); and faceting are the most commonly known. Each calls for a different and precise technique, as well as special tools and machinery.

The mastering of one of these branches of the art may completely satisfy an amateur's need for a hobby. In some cases, one may gain a reasonably proficient grasp of one branch, and then go on to master in the same manner another

allied branch. For instance, one who has cut many cabochons may find it a fairly easy transition to make intaglios or carvings. Usually, one who has started with tumbled gems, wishing to exercise more control over stone shape, will enter into the cutting of cabochons. Other transitions may also take place.

It is of interest to note that most branches of gem cutting entail the use of a skilled hand. The more intricate the process, the more important is the training and control of the hand. The case of faceted gems is a partial exception to this rule. It is true that a faceting machine must be guided and controlled by hand, but the machine is of the greatest importance. The producing of a faceted gem calls for the precise placement of a number of perfectly flat faces upon the gem. This can best be done with the aid of a reasonably rigid and accurate machine; which in turn calls for a definite operating skill.

The raw material of most forms of gem cutting can be of complete or nearly complete opacity. Only seldom are carvings, cabochons, intaglios, etc., cut from anything but opaque to translucent stone. In these forms, the art expression centers around color and any patterns the stone may have, and this offers the artist a myriad of possibilities.

The raw material needed for faceting is quite different. To produce the best in faceted gems, one must have the clearest, most transparent piece of rough material. It is true that flawed, or even opaque material is sometimes used for this purpose, but the results, however interesting, cannot be favorably compared with a clear flawless gem.

These two exceptions, machinery and type of rough material, set facet cutting apart from the other branches of the art of gem cutting. The exceptions, however, do not make the work especially easy, nor more difficult. They simply call for different handling of the gemstone during the cutting and polishing processes. In the end an entirely different gem is created.

The cutting of faceted gems is an exacting procedure. The good facet cutter is concerned with the precise placement, shape, size, and polishing of the facets that completely surround what is known as a faceted gem. Correctness of the above operations sets the theme for this book.

These operations require at least a rudimentary knowledge of the sciences of optics, solid geometry, and mechanics. Some aspects of these sciences are very involved and intricate, and might tend to frighten off many potential facet cutters. The field of optics, as an example, calls for delicate and costly instruments in order to make exacting determinations. Most amateur gem cutters do not wish to make the necessary financial outlay nor take the time to learn to use such instruments.

It is possible for one to plunge headlong into such intricacies and become an expert in these sciences; or one can simply accept certain statements as true, and cut faceted gems based entirely upon another's determinations. Obviously then, there is a wide degree of latitude between these two extremes, and any faceter may progress as far as he wishes into these sciences. The approach is toward this intermediate realm, with the hope that this work will permit the individual to achieve any degree of proficiency he wishes, but not to force him past this point.

The aim is to give the faceter the basic information that he must have, and to

show him how and why the various behaviorisms of gems and machinery are very important; and most of all, to present them in a manner that is completely understandable regardless of the individual's previous interests and training. All aspects of faceting are handled here in such a manner that only a good faceting machine, and a few commonly used household articles are needed to gain the full enjoyment from this most rewarding hobby.

One of the most astonishing facts about faceting is that there are few hard and fast rules governing it, and even these may be violated at times with a reasonable degree of success. All rules are covered to the extent that it seems necessary, and the reasons for them are explained as carefully as possible.

There are many operations that are not dependent upon rules, and the various methods of accomplishing these are explained thoroughly. Those methods which the authors have tried without great success are covered in much the same manner as those that were found to be best. Some of these, found to be of little value to the authors, are known to be quite successful for other faceters.

In the past three decades, a large number of individuals have found that the art of cutting faceted gems is neither difficult nor steeped in mystery. It is for all who have tasted the thrill of cutting faceted gems, and wish to gain new skills; as well as those who have looked at the art with longing from afar, that this book has been written.

Chapter I

Gems Are Minerals

IT MUST FIRST be understood that gems are minerals, usually in their purest form. Each gem species is a distinct mineral, and thus a distinct chemical in its own right. A few gems are of animal or plant origin, such as ivory, bone, amber, and wood; and are not usually considered as minerals. Some authors do treat these gem materials as minerals, and the arguments that are presented are very sound. In the final analysis, all gems are to be considered as separate chemical entities, and all but the few examples noted above are natural-occurring substances to be found within the earth's crust.

The faceter works with minerals with perhaps the exception of amber and also the seeming exception of glass. Glass is a mixture of minerals treated by man. In the eyes of most authorities this treatment does not remove it from the mineral category.

Nearly all gems are minerals, but a mineral does not become a gem until it is cut and polished.

COMPOSITION OF MINERALS

All minerals (as well as all things appearing on earth) are composed of various atomic elements combining to form molecules. There are only a limited known number of elements and they are listed in Table 1. This list is small, but most of the elements are capable of combining in groups of varying numbers to form many millions of items that we know and use every day. Of this group, a few thousand are what we know as minerals.

TABLE 1

THE ELEMENTS

Name	Symbol	Name	Symbol
Aluminum	Al	Mercury (hydrargyrum)	Hg
Antimony (stibium)	Sb	Molybdenum	Mo
Argon**	A	Neodymium*	Nd
Arsenic	As	Neon**	Ne
Barium	Ba	Nickel	Ni
Beryllium	Be	Nitrogen	N
Bismuth	Bi	Osmium*	Os
Boron	B	Oxygen	O
Bromine*	Br	Palladium*	Pd
Cadmium*	Cd	Phosphorus	P
Calcium	Ca	Platinum*	Pt
Cesium*	Cs	Potassium (kalium)	K
Carbon	C	Praseodymium*	Pr
Cerium	Ce	Radium*	Ra
Chlorine	Cl	Radon**	Rn
Chromium	Cr	Rhenium*	Re
Cobalt	Co	Rhodium*	Rh
Columbium	Cb	Rubidium*	Rb
Copper (cuprum)	Cu	Ruthenium*	Ru
Dysprosium*	Dy	Samarium*	Sm
Erbium*	Er	Scandium*	Sc
Europium*	Eu	Selenium*	Se
Fluorine	F	Silicon	Si
Gadolinium*	Gd	Silver (argentium)	Ag
Gallium*	Ga	Sodium (natron)	Na
Germanium*	Ge	Strontium	Sr
Gold (aurum)	Au	Sulfur	S
Hafnium*	Hf	Tantalum	Ta
Helium**	He	Tellurium*	Te
Holmium*	Ho	Terbium*	Tb
Hydrogen	H	Thallium*	Tl
Indium*	In	Thorium	Th
Iodine*	I	Thulium*	Tm
Iridium*	Ir	Tin (stannum)	Sn
Iron (ferrum)	Fe	Titanium	Ti
Krypton**	Kr	Tungsten (wolframium)	W
Lanthanum*	La	Uranium	U
Lead (plumbium)	Pb	Vanadium	V
Lithium	Li	Xenon**	Xe
Luticium*	Lu	Ytterbium*	Yb
Magnesium	Mg	Yttrium*	Y
Manganese	Mn	Zinc	Zn
		Zirconium	Zr

The names in parentheses are the Latin names responsible for the symbol. * Denotes elements seldom found in minerals. ** Denotes elements that do not appear in any minerals, as they are normally inert gases.

TABLE 2

CHEMICAL CONSTITUENTS AND SUBSTITUTIONS IN SOME MINERALS

Mineral	Formula	Remarks
Halite	NaCl	Sodium chloride
Quartz	SiO_2	Silicon dioxide
Tourmaline	$R_9Al_3(BOH)_2Si_4O_{19}$	R may equal any of the following: Mg, Fe, Ca, Na, Li, F.
Zoisite (Orthorhombic)	$HCa_2Al_3Si_3O_{13}$	Little or no iron in molecule
Clinozoisite (Monoclinic)	As zoisite	Less than 10% iron replacing the aluminum
Epidote (Monoclinic)	As zoisite	Over 10% iron replacing the aluminum

---

Some minerals are quite simple in composition, being formed of only one or two elements. Ordinary table salt and quartz are good examples. Salt, mineralogically known as halite, has molecules composed of one atom of sodium and one atom of chlorine, tied together with a strong electrical bond. Quartz is composed of one atom of silicon and two atoms of oxygen. These are bonded together so effectively that it is very difficult to tear them apart. Gold is an example of a mineral appearing in the form of the pure element, and is not a compound as are those above. A book on mineralogy or chemistry will completely explain the composition of minerals, native elements, and the bonds that tie them together.

Most minerals are not as simple as the examples given above, and are not always held together with strong bonds. When many minerals were originally formed, many of the atoms that should correctly have gone into the compound were substituted for by others. The resulting mineral is either impure, or to be considered as an intermediate form between two minerals. Tourmaline is a good example of one that may have many element substitutions, and still remain as tourmaline. It has such a variable chemical structure that the formula is very seldom written out completely, but is expressed in part by symbols which denote a variety of possibilities. Table 2 lists the various minerals and formulas under discussion. Epidote is an example of a mineral that may appear as an intermediate form if the correct substitutions were made at the time of its formation.* Normal epidote contains about 10% of iron in its molecule. If the amount of iron falls much below that figure, the characteristics of clinozoisite will appear. Aluminum, magnesium, or other elements may substitute for the iron in clinozoisite.

*See - A Textbook of Mineralogy, Dana; page 622

Seldom does any mineral appear in nature in an absolutely pure form. In many instances, the impurity may be present in such small amounts that it produces a separate and distinctly colored material. If the mineral so formed is of gem quality, it may be given a separate gem name. In other cases, the impurities are in the form of inclusions of varying sizes. For the most part, such inclusions or impurities, even though they may be of concern to the faceter, do not alter the basic chemical makeup of the mineral.

Chemical Formulas

Mineralogists have divided all minerals into a number of groups depending upon their chemical formulas. Table 4 shows the groups into which the most common gem minerals are classified. Gem minerals appear in each of these groups. The group known as the silicates (in which a combination of silicon and oxygen is further combined with one or more metallic elements) contains the largest number of minerals. As might be expected, the silicates also contain the largest number of gem minerals. The group known as the oxides (a combination of a metal and oxygen) produces the next largest group of gems. The remainder of the gem minerals are distributed sparingly among the other groups. It will be observed in the table that the silicates and oxides, for the most part, are over 7 in hardness (see Moh's scale of hardness, Table 3) while the sulfides and carbonates are less than 4. If the diamond (a native element) is excluded, the oxides as a group produce the hardest gems.

Mineral Crystals

When conditions of mineral formation are correct; that is, when impurities and substitutions are below a certain point dictated by each mineral, the mineral will be found in the form of crystals. A crystal is a reasonably regular geometric form bounded by a number of flat faces. These faces lie in certain relation to all other faces on the same crystal, and are governed by certain laws regarding their formation. Figure 1 shows some examples of mineral crystals.

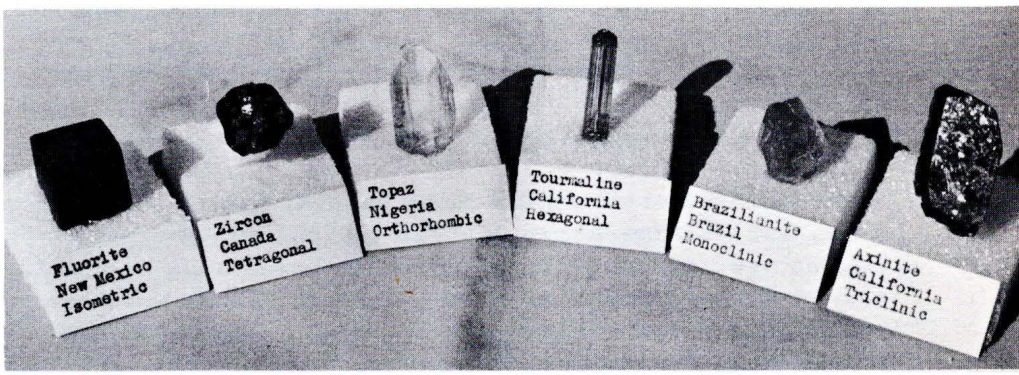

Figure 1.
Example of the Six Crystal Systems.

Continuously repeated regular combinations of atoms result in the regularity of mineral crystals. These repeated patterns are called crystal lattices. The crystal lattice of halite is shown in Figure 2. It will be noticed that the spots at the juncture of lines are either solid or rings. The rings in this case could indicate sodium atoms, the solid spots could indicate chlorine atoms. A group of four of each, enclosing a cube, makes up a space cell. The crystal of halite is usually in the form of a cube, as the cell infers.

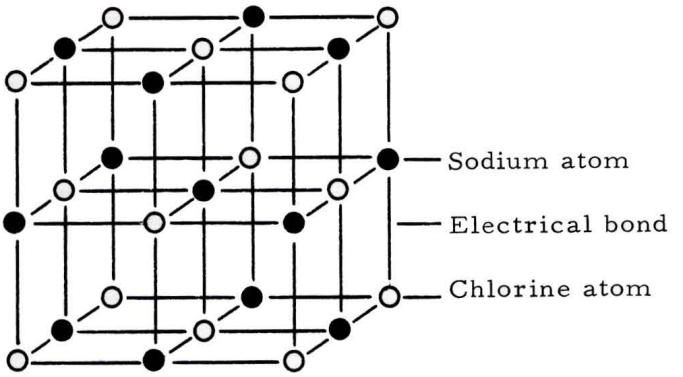

Figure 2.
A Crystal Lattice of Halite (ordinary salt).

A certain number of silicon atoms and another number of oxygen atoms constitute a quartz space cell. A repetition of these space cells into a crystal lattice, with a further repetition of hexagonal space cells, will result in the hexagonal shaped crystal of quartz.

TABLE 3

MOHS SCALE OF HARDNESS

1. Talc
2. Gypsum (fingernail - 2.5)
3. Calcite (copper coin)
4. Fluorite
5. Apatite
6. Orthoclase (ordinary knife blade)
7. Quartz
8. Topaz
9. Corundum
10. Diamond

Mohs scale of hardness is based entirely on comparison. On a relative basis, diamond is a number of hundred times harder than corundum, which in turn is a number of times harder than topaz. Other inequities exist in the balance of the scale. All that Mohs scale was intended to indicate is that a certain mineral is harder or softer than another, and a definite number was assigned to each.

The Crystal Systems

Crystaline minerals exhibit many shapes; calcite alone has over one-hundred forms, but all mineral crystals fall into one of six crystal systems. These systems are regular geometrical solids based upon lines that may be drawn between opposite points within the crystal. These lines are called crystal axes and are illustrated in Figures 3 through 5. Each of the six systems differ from each other by the length of these axes, their number, and the angles at which they intersect within the crystal.

The Isometric System

If we should take as an example, a cube (Figure 3A) and draw a line (an axis) between all opposite faces, we would find that we have three such lines (a-b, c-d, e-f) all of equal length that meet and cross each other at 90°, with the intersection in the exact center. The cube is the simplest form of the isometric system; other forms are shown in Figure 3. All of these forms have the axial

TABLE 4

PHYSICAL PROPERTIES OF THE COMMON GEMS

Gem Mineral	System	Hardness	Cleavage		Colors
SILICATES					
Topaz	Orthorhombic	8	one	high	four
Beryl	Hexagonal	7½-8	one	low	five
Zircon	Tetragonal	6½-7½	two	low	five
Andalusite	Orthorhombic	7-7½	three	moderate	two
Tourmaline	Hexagonal	7-7½	two	low	seven
Quartz	Hexagonal	7	none	---	five
Garnet	Isometric	6½-7½	none	---	four
Danburite	Orthorhombic	7	one	low	two
Axinite	Triclinic	6½-7	one	low	one
Peridot	Orthorhombic	6½-7	two	low	one
Spodumene	Monoclinic	6-7	two	extreme	four
Benitoite	Hexagonal	6-6½	one	low	one
Opal	Amorphous	6-6½	none	---	three
Orthoclase	Monoclinic	6	three	moderate	three
Sphene	Monoclinic	5-5½	three	low	three
OXIDES					
Corundum	Hexagonal	9	three	low	five
Chrysoberyl	Orthorhombic	8½	three	low	three
Spinel	Isometric	8	one	low	four
PHOSPHATES					
Brazilianite	Monoclinic	5½	two	moderate	one
Apatite	Hexagonal	5	two	low	five
CARBONATES					
Calcite	Hexagonal	3	three	high	two
Rhodochrosite	Hexagonal	3½-4½	three	high	one
HALOIDS					
Fluorite	Isometric	4	four	high	five
SULPHIDES					
Sphalerite	Isometric	3½-4	six	high	three
HYDROCARBONS					
Amber	Amorphous	2-2½	none	---	two
NATIVE ELEMENTS					
Diamond	Isometric	10	four	high	seven

Gems are listed in order of decreasing hardness within each group. Column four, under cleavage, gives the number of cleavage planes. Column five indicates the magnitude of the problem created by the cleavage. The number of cleavage directions includes, in some cases, those which are seldom a problem to the faceter. The number of color varieties are conservative figures. Some of the above also have a number of shades of each color.

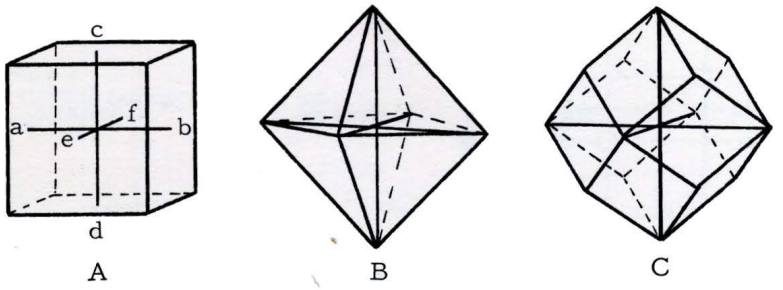

Figure 3.
The Isometric Crystal System. The cube A, as in fluorite. The octahedron B, as in spinel. The dodecahedron C, as in garnet. The horizontal and vertical lines, a-b, c-d, e-f, within each figure are the crystal axes.

relationship in common as outlined above. In the case of the octahedron, Figure 3B, the axial lines are drawn between corners. A number of gem minerals occur in this system.

The Tetragonal System

The second crystal system, known as the tetragonal system is exactly square in cross section, and therefore has two axes of the same length. The third axis, usually considered to be vertical, may be either longer or shorter than the two equal ones. All three meet at 90° and intersect at the exact center of the crystal. Examples of the tetragonal system are shown in Figure 4. The axis of variable length is known as the c axis and offers some interesting possibilities. Crystals may be either flat tablets as in Figure 4C, or as long prisms as in Figure 4B. The important feature of this system is the square cross section at right angles to the c axis.

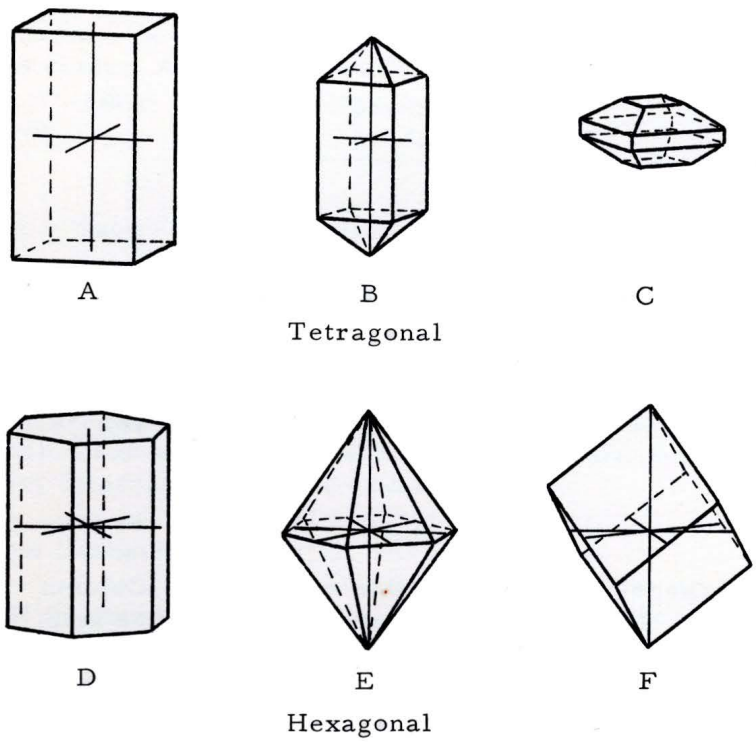

Figure 4.
The Tetragonal and Hexagonal Crystal Systems.
The prism A, as in andalusite. The prism and pyramid B, as in zircon. The flattened prism, pyramid, and pinacoid C, as in wulfenite.
The hexagonal prism D, as in beryl. The pyramid E, is sometimes exhibited by quartz. The rhombohedron F, as in calcite.

The Hexagonal System

The hexagonal crystal system, as the name implies, has a six-sided cross section. The c axis is longer or shorter than the other three axes, which are of equal length and intersect each other at 60° and intersect the c axis at 90°. Examples of this system are shown in Figure 4. There are many variations of this system, such as the rhombohedron, Figure 4F, which has a true hexagonal outline, even though no face (rhomb) shows this feature. Many minerals form in the hexagonal system and a large percentage are cut into gems.

The Orthorhombic System

If three axes are of different lengths, but intersect at 90° in the center of the crystal, we have the orthorhombic system, Figure 5. In this system, the c

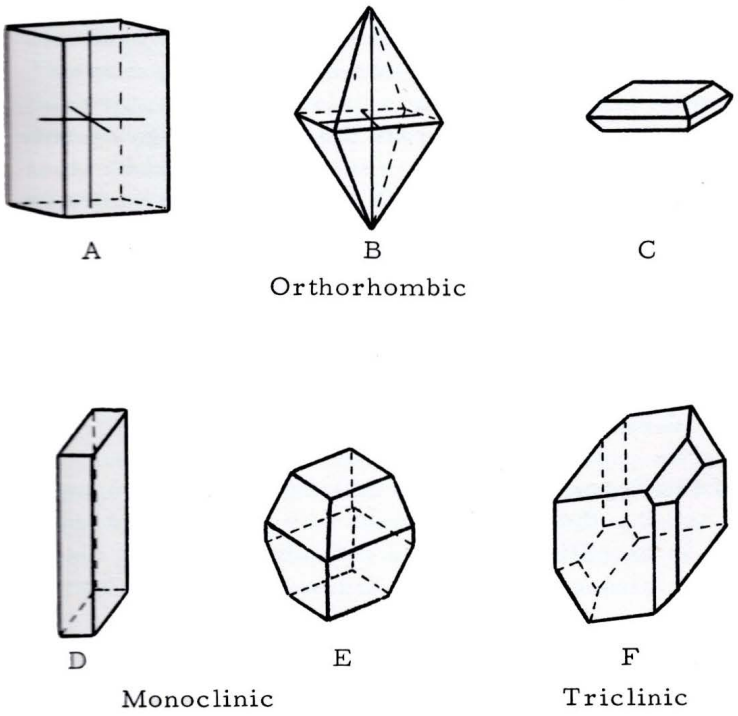

Figure 5.
The Orthorhombic, Monoclinic, & Triclinic Crystal Systems. The prism A, is sometimes exhibited by Topaz. The pyramid B, as in sulfur. The pyramid and basal pinacoid C, as in barite. The prism D, is sometimes exhibited by orthoclase feldspar. The pyramid E, in combination with other forms, as in sphene. The form F is taken by axinite.

axis is considered to be vertical, thus any cross section is a rectangle. As a result of the completely unequal axial length of this system, there is a great possibility of variation within it and many minerals assume this form. It is interesting, however, that few gem minerals are to be found in this system as is shown in Table 4. The gem minerals that do form in the orthorhombic system are very important.

The Monoclinic System

Three of the systems discussed above have axes intersecting at 90° even though axial lengths vary between the systems. In the monoclinic crystal system, the axial lengths are much like those in the orthorhombic system, but now one axis intersects the other two at an angle other than 90°. Many examples of this system have a rectangular cross section, but the view through another direction will show no corners with 90° angles. Figure 5 D&E shows

examples of crystals of the monoclinic system. As the limitations of this system are not great, a large number of minerals crystalize within it. A proportionately large number of these are gem minerals.

The Triclinic System

The only other mathematical possibility remaining in this series is to have three axes of varying lengths with none intersecting at 90°. This feature is exhibited by the triclinic crystal system, shown in Figure 5F. It is interesting that such a system would appear to allow infinite variation, but actually it does not, and so very few minerals form triclinic crystals. One of these, axinite, is a very rare and interesting gem.

Amorphous Minerals

Some minerals that never form crystals are known as amorphous minerals, or minerals without regular form. In this case there are molecules composed of atoms as in other minerals, but there is a total absence of a crystal lattice, and thus no crystal form. This type of form is rare in mineralogy, but opal and amber are examples. Obsidian and its man-made relative, glass, are further examples. In all cases of amorphous minerals there is no regular outward form except when another mineral in crystaline form is replaced by it. Such a replacement is known as pseudomorphism, with the end result known as a pseudomorph. A text on mineralogy will describe a number of examples of this phenomenon.

Opal, the most common of the amorphous minerals, is still under discussion as to its exact makeup, but most authorities consider it to be in this group.

PHYSICAL PROPERTIES OF MINERALS

Minerals may be said to be of two types: 1. Those that are normally opaque and never appear transparent, and 2., those that on occasion are transparent. A good example of the first type is hematite, which is cut into unique jet black gems. Almost any well-known gem mineral, such as tourmaline, could be an example of the second.

The faceter is primarily interested in the second type, but it must be very strongly emphasized that the percentage of occurrence of transparent specimens of any mineral is quite small. Some minerals appear transparent with greater frequency than others, but in no case is the percentage very great.

Since many minerals never appear in a transparent form, and the occurrence of gem minerals in the transparent form is rare; we must realize that the faceter is drawing his materials from an almost infinitesimal portion of the earth's crust. This may appear as if we were searching for the proverbial needle in the haystack. Things are really not as bad as they may seem; minerals have the tendency to concentrate in small areas and in certain regions gem materials may be found in aggregations of reasonable numbers. Methods of occurrence of minerals will not be discussed here, and the reader is referred to any good book on mineralogy. Some of the best are listed in the bibliography.

Hardness of Gems

The person who is producing gems with the aim of mounting them into jewelry must necessarily choose those types that have the greatest resistance to wear. The most common abrasive agent that normally contacts gems is ordinary dust, of which the greatest part is the mineral quartz, with a hardness of 7 (see Table 3). This fact quickly becomes disconcerting when it is realized there are few gems with a hardness of 8 and above. Only one gem, the diamond, has a hardness of 10. Two gems, ruby and sapphire, both color varieties of the mineral corundum, are the only ones with a hardness of 9. Topaz, spinel, chrysoberyl, and one or two other rare minerals are between 8 and 9 in hardness. It is reassuring, however, that it is somewhat difficult for a mineral of 7 to scratch another of 7 or slightly over.

It is fortunate that there is a fairly large number of gems with a hardness range of from 7 to 8, and it is from this group that the average faceter will be choosing most of his materials. Of the greater hardness gems, diamond is out of the question except for the gem cutter of great skill and special equipment. The corundum gems (except for the synthetics) are seldom available because of their great rarity and demand. Spinel and chrysoberyl are also rare, but are occasionally available. Topaz is the only gem of 8 in hardness that is always to be found on the market. As a result, the faceter must for the most part satisfy himself with the gems from 7 to 8 in hardness. Another glance at Table 4 should convince one that this is no great hardship, when it is seen that the group of gems from 7 to 8 in hardness also has a very good representation of color varieties.

Gems below 7 in hardness, such as sphene and apatite have been popular for years for jewelry such as earrings and pendants. Under such wearing conditions they are not subjected to great abrasion. Recently there has been an increased interest in the soft gems. Many advanced faceters have been cutting fine gems from this type in spite of the difficulties encountered in cutting and polishing.

The feeling of accomplishment when finishing such a gem is well worth the extra effort. Chapter XII is devoted entirely to the handling of the softer gem materials.

Cleavage in Gem Minerals

The tendency of a mineral to split along a straight line, producing a flat surface, is called cleavage. This is one of the most important considerations of the physical properties of gems. Few gems do not exhibit cleavage, quartz being the most notable example. Some others, such as beryl, have a very poor cleavage, and are usually handled as if they had no cleavage. A great number of gems exhibit a moderate cleavage which is really not troublesome during gem cutting; while some, such as topaz, have a single very easy cleavage. Other gem minerals have such an easy cleavage that cutting them into gems seems almost an impossibility.

To further compound the problem, some minerals have a cleavage in more than one direction, with some such as sphalerite, being cleavable in six directions. Other minerals exhibit a phenomenon called parting, which is mineralogically different from cleavage, but to the faceter they are identical or nearly so. The mineral spodumene (kunzite, hiddenite, etc. as gems) has an easy

parting, and is very difficult to cut. Table 4 also lists the number of cleavages for the common gems. The species descriptions in Appendix I lists the cleavage characteristics for all gem materials. The faceter should make a real effort to know and understand cleavage and how to contend with it.

Specific Gravity

The relationship of minerals to water from the standpoint of weight per unit is called specific gravity. A mineral that is three times heavier than water is said to have a specific gravity of 3, etc. Specific gravity is of importance to the faceter in only two aspects, and neither will usually be of significance. A gem of high specific gravity will be of a smaller size for a given carat weight than one of a lower specific gravity. If a faceter finds that he must identify gem materials, he may wish to determine the specific gravity as part of the process. In the case of cut gems, specific gravity can be very important as it is a simple test that can be made without costly instruments, and without possibility of damage to the gem. The average gem cutter will seldom need to identify his materials, but if the need arises, he should be familiar with the process. Any text on gemology or mineralogy will cover specific gravity determinations.

Fracture

All gem materials will break under stress. The type of surface produced when a mineral breaks is known as a fracture surface. The appearances of the fracture surfaces can be an excellent aid in correctly identifying rough gem materials. During the cutting process, the faceter may experience the fracturing of a gem, but the type of fracture at this point is of little importance. Two features of fracture are brittleness and toughness. A gem material that is brittle will fracture very easily, while toughness is the opposite characteristic. Obviously, a gem material cannot be tough and brittle at the same time. Some very tough materials break into a number of small fragments when the limit of stress is finally reached. The breaking of a mineral into a number of fragments is a behaviorism of fracture, and not necessarily a gauge of brittleness.

Luster

Mineral surfaces reflect light in different intensities. Luster is the term used to describe this reflection. It is a combination of the condition of the surface, transparency and reflectivity of the material, and the refractive index. As shown in Chapter VI, refractive index is a measurement of the amount that light is bent within the gem material. The kinds of luster are listed in Table 5. All are self-explanatory with the exception of adamantine. This type of luster is confined to the gem materials of high refractive index. Metallic luster is not included in the table, as none of the gem materials exhibit true metallic luster. Some gems show a tendency toward this luster, but it is always in combination with one of those listed. Luster is a combination of physical and optical properties, and the two features are very difficult to separate at this point. The optical properties of gems are discussed in Chapter VI.

The faceter should make a careful study of physical properties of gems, so that he may be in a position to completely understand any unusual properties of any gem materials he may encounter. The species descriptions of gem minerals in Appendix I lists the physical properties of importance to the faceter, and notes any that are of an unusual nature.

TABLE 5

LUSTER OF GEM MATERIALS

ADAMANTINE	A high reflectivity associated with a high refractive index.
VITREOUS	The appearance of freshly broken glass.
RESINOUS	As the name implies; the appearance of ordinary resin.
GREASY	Again as implied; the appearance of a greasy surface.
PEARLY	An iridescent appearance, much like the surface of pearl.

There is another very important type of luster, metallic. None of the true gem materials shows metallic luster, so it has been deleted from this table. It is very possible for a mineral under one condition to show one type of luster, and under other situations show another. It is also possible for a mineral to show one luster on one crystal face or cleavage surface, and a second type of luster on other surfaces. A book on mineralogy will give and explain specific examples.

Chapter II

Faceting

Machines

WHO CONCEIVED THE first faceting machine and when, is lost in antiquity. However, crude faceted gems were known by the 14th century,* and there is evidence of an earlier date. The first work was apparently done in India, probably with the impetus from the diamonds found in the mines near Golconda. It is of significant interest that the first faceting work was evidently done on diamonds, the most difficult of materials to cut and polish. If this is not true, then rubies and sapphires were the pioneer materials. With the crude equipment that was used, rubies or sapphires would have been only slightly easier to cut than diamonds. This early work must be recognized as a great accomplishment, when we realize that even today the cutting of diamonds is essentially beyond the scope of the amateur, and that the handling of ruby and sapphire is usually not attempted until the amateur has developed a refined technique on softer materials.

THE REQUISITES OF A FACETING MACHINE

A faceting machine must enable the operator to place small flat surfaces, called facets, at various angles from 0° to 90° as illustrated in Figure 6. This will allow control of the depth of the final gem and also permit placement of any reasonable number of rows of facets along the vertical line or axis of the gem. The machine should also facilitate the placement of these facets at any predetermined number of points around the circumference of the gem.

*See - Gemstones, Smith; page 155. Also see - Gems, Webster; page 358.

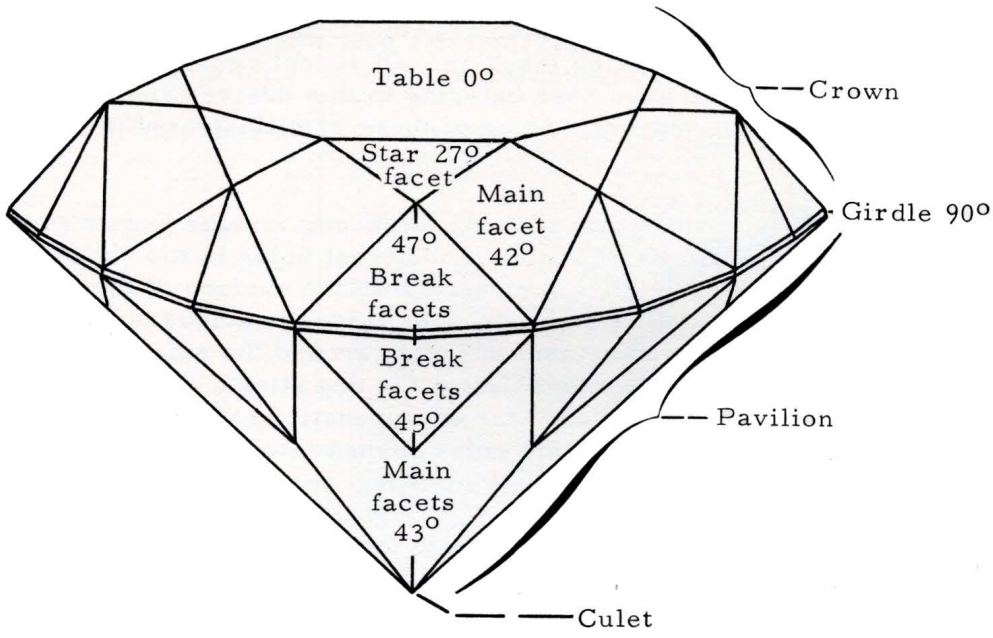

Figure 6. The Modern Standard Brilliant Gem. Angles are for Quartz.

The first of the faceting machines did this, but not with any degree of accuracy. Any approach to precision was dependent upon the skill of the operator. The name for this early machine (and its later similar types) is the jamb-peg, one of which is illustrated in Figures 7 & 8. This machine was developed in Europe

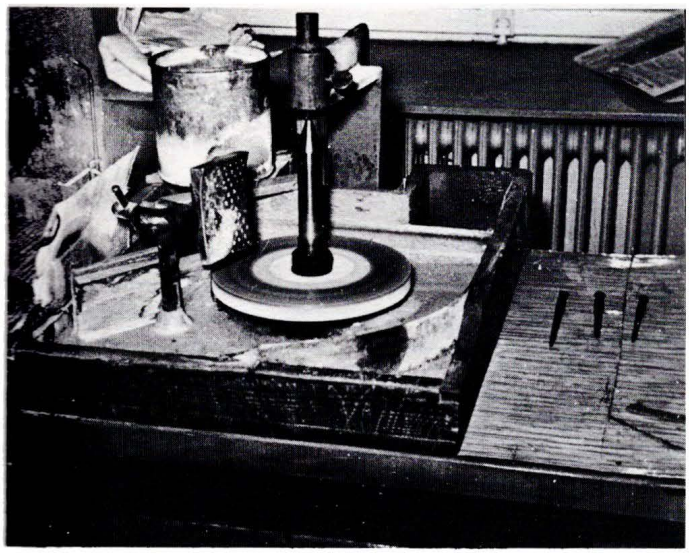

Figure 7. The Jamb-peg Faceting Machine.

Figure 8. The Jamb-peg Faceting Machine in Use. Photographs by Lowell Keeley

and is still used in many parts of the world. Any refinements of the original machines were few until recent years. The parts of the jamb-peg machines varied considerably in shape and size, but the basic design remained unchanged.

Any machine that places accuracy as a secondary criteria would not be very

attractive to amateurs. The amateur cuts gems primarily for enjoyment and thus insists upon a close approximation of perfection, so he must look to other than the jamb-peg for his faceting machine. Of recent years, a number of individuals and companies have been catering to this desire, and many fine machines are now on the market. Some of these are illustrated in Figures 9 to 15.

From Figure 7 it is obvious that with the jamb-peg various angles can be attained by placing the peg or dop stick in different holes in the vertical peg board. The angle of the dop stick, in relation to the surface of the cutting lap wheel, decreases as the dop stick progresses through various holes downward toward the lap wheel. The placement of facets around the axis of the gem must be accomplished entirely by eye by twisting the dop stick a small amount from the previous position. It is obvious that this operation calls for great skill. This feature led to the dop having the sides shaped into an octagon and being allowed to ride against a plate during the cutting process. It was possible with such a machine to cut a nearly perfect eight-sided gem. Further developments led to the use of gears with 32 or more teeth to facilitate the accurate placement of facets. Eventually a protractor replaced the peg board, now enabling the operator to precisely place the facets at any desired degree. When faceting machines reached this stage of development, we had the basis for the modern types.

Modern Faceting Machines

No attempt will be made to describe the various makes of faceting machines presently on the market. All of them fall into one of two basic types, the mast and staff, and the platform. Each follows the same basic principle, but differs in constructional and operational details.

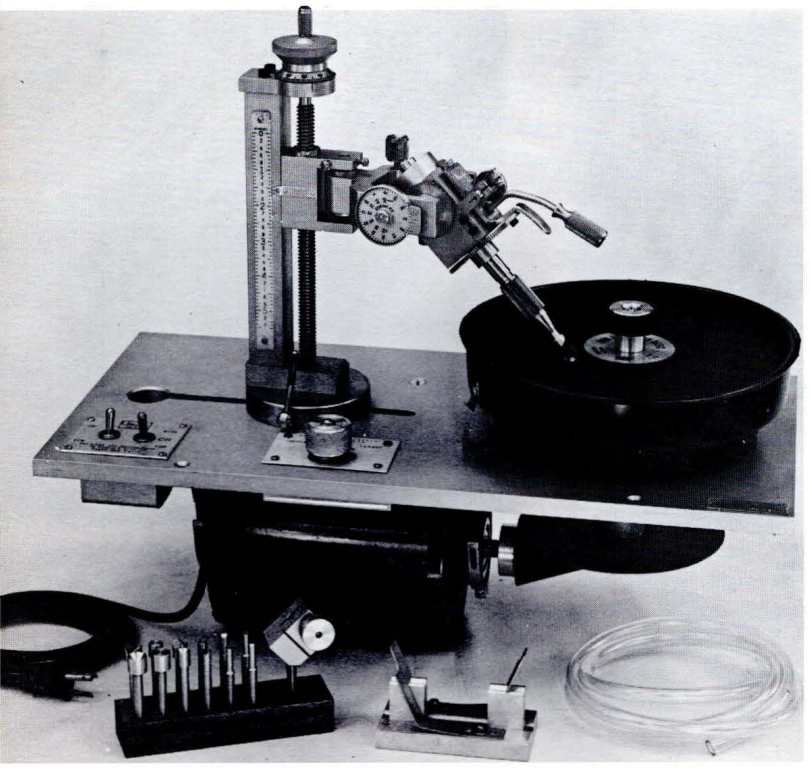

Figure 9.
The Ultra Tec Faceting Machine

Photograph courtesy of
Howard E. Stanley
Lapidary Products.

The most common of the two types, the mast and staff, shown in figures 9 to 12, is a derivation of the jamb-peg refinements. Figure 10 shows a typical machine with the parts letter-coded and described below.

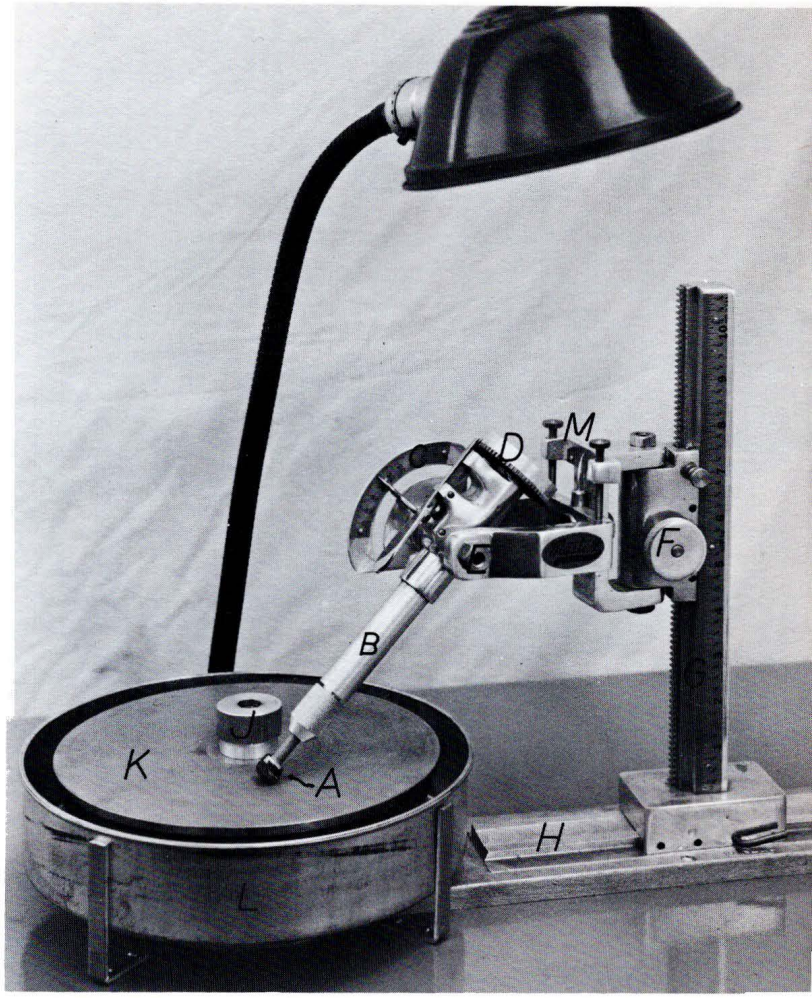

Figure 10.
The MDR Master Faceting Machine

Photograph courtesy of
M.D.R. Manufacturing Co.

The stone (A) is shown at the end of the staff B. This end of the staff is a hollow tube, and is sometimes known as the quill. The stone is cemented to a rod known as a dop stick, which is inserted into the quill. On the opposite end, and in line with the axis of the staff, is a notched or toothed gear known as the index gear, or simply the index. The staff rotates on its axis, and the index holds the stone at a chosen point while a facet is cut by the lap K.

Attached to the staff is the protractor pointer to be seen against the protractor C. The complete staff unit moves through a vertical plane around the pivot point E. The pointer indicates the angle between the staff and the lap. The protractor and its related parts is illustrated in Figure 13.

The knob F is used to raise and lower the staff and protractor unit on the mast G. These are connected by a vertical hinge arrangement which allows the staff (and stone) to be moved horizontally across the lap. The slide rail H facilitates horizontal movement of the complete unit. This complete unit is sometimes known as the faceting head.

The lap is held to the rotating arbor by the center nut J. The splash pan L prevents lap lubricant or polishing agent from being thrown from the machine. The cheater unit M is illustrated in Figure 16.

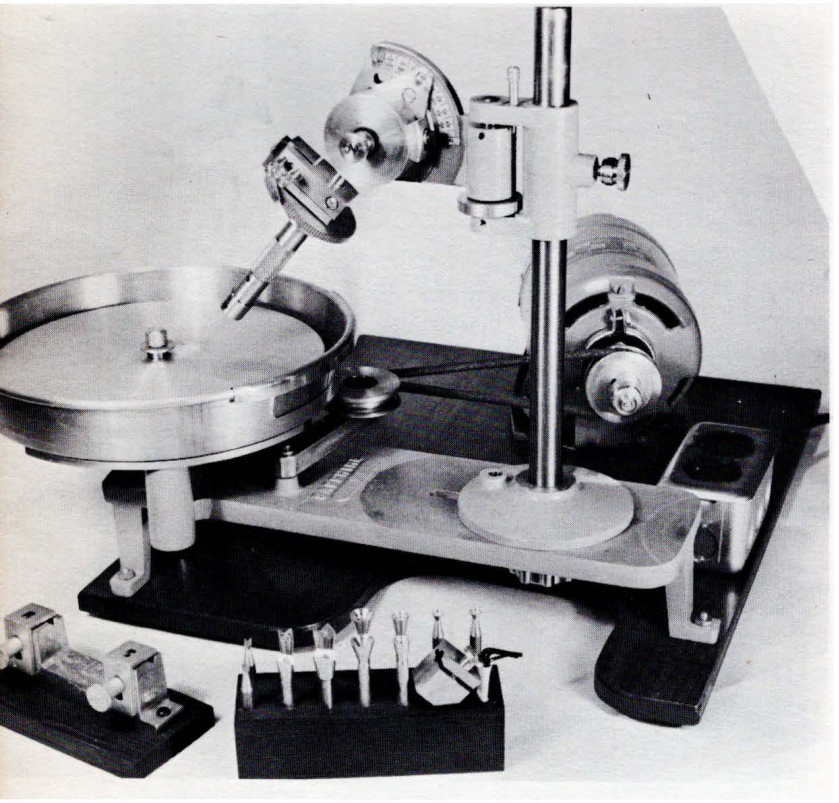

Figure 11.
The Sapphire Faceting Machine
Photograph courtesy of
Arrow Profile Company..

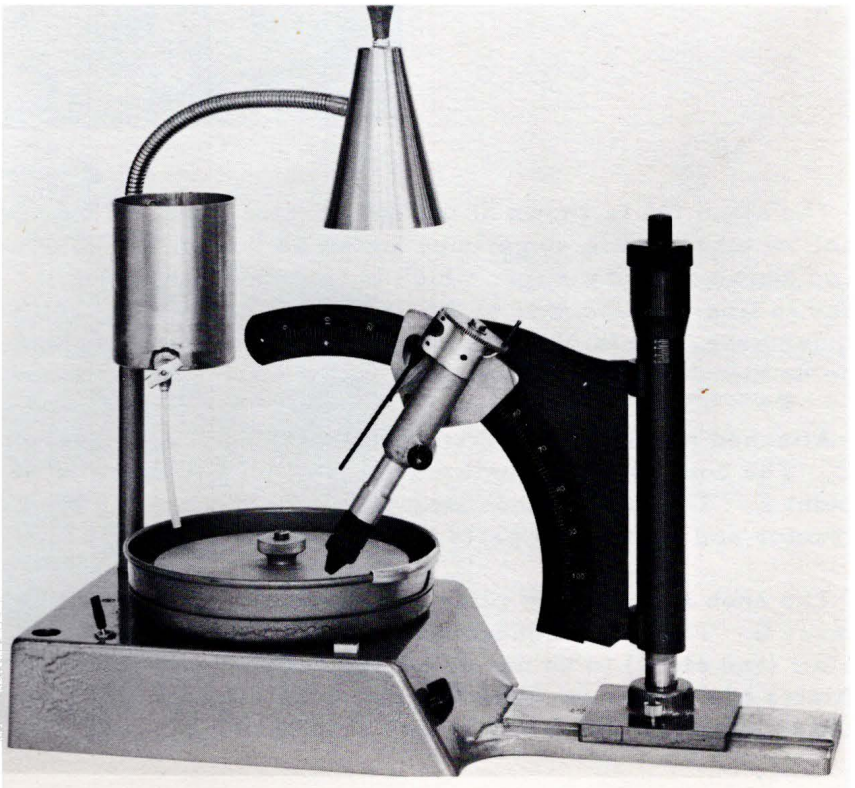

Figure 12.
The Facette Faceting Machine.
Photograph courtesy of
Facette Incorporated.

The protractor as shown in Figure 13 is ordinarily divided into an arc of 90°. The protractor pointer indicates the degree at which cutting or polishing is taking place. The complete unit, consisting of the quill and the indexing device (not shown) rotates in a vertical plane around the pivot point. The gem (also not shown) is attached to a dop stick which is inserted into the dop channel. Some type of locking device at the tip of the quill holds the dop stick in place. The quill is sometimes called the dop arm or dop holder. The angle stop is designed to stop the downward swing of the quill, and thus stops cutting at any predetermined point. The angle stop is adjustable around the arc of the protractor.

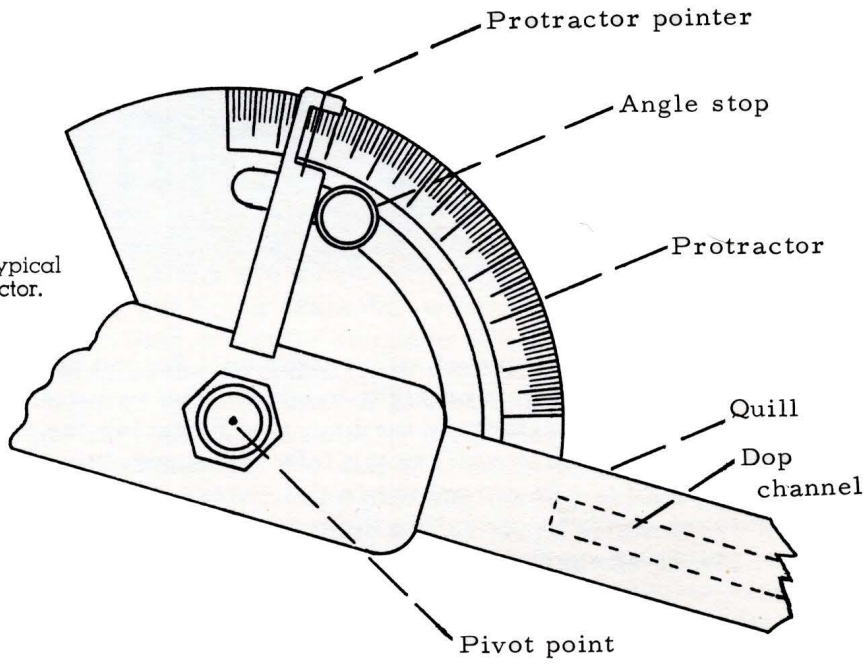

Figure 13.
Schematic View of a Typical Faceting Machine Protractor.

Nearly all machines allow an interchange of index gears with varying numbers of notches. This will allow the cutting of gems with different mathematical divisions; thus the number of circumference facets may be limited only by the number of index gears or their number of notches.

Some machines allow the removal of the staff from the mast in order that the work may be carefully inspected. This feature is a decided advantage in that the facet to be examined may be turned exactly toward the best light.

The platform type faceting machine, Figures 14 and 15, is derived from the mast and staff type, and differs in that the portion which corresponds to the mast is instead a flat plate upon which the staff portion is placed. The great advantage here is that the quill may be easily and quickly removed from the balance of the machine for inspection of the work. The staff portion is easily replaceable with complete accuracy. When desired, the staff can be placed on nearly any portion of the lap without any adjustments to any part of the machine.

Right and Left Hand Machines

Most machines are designed for the quill to be moved across the lap with one hand. Some allow the use of only the left, others only the right, and a few may

Figure 14.
The Scott Faceting Machine.
Photograph courtesy of
Branford Craft Tool &
Supply Company.

be used either way. The use of either hand will depend somewhat upon the individual and whether he is left or right-handed. The experience of the authors has shown that the most satisfactory method is to be facing the machine so that the lap is to the right, and the quill to the left. It is possible for any right-handed individual to learn to use a machine in the reverse position, but the attendant jobs of faceting, such as operating the motor switch, adjusting wetting sponges, placing of polishing agent on the wheel, etc., must be done with the left hand under these circumstances. The quill-to-left position is far simpler for this type of individual.

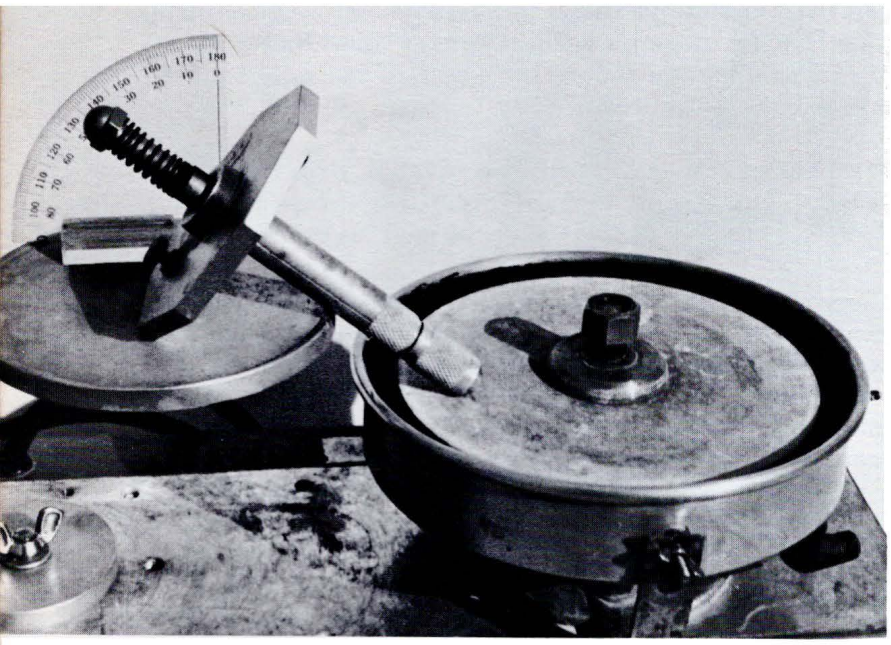

Figure 15.
The O'Brien Faceting Machine.

Even though the illustrations show only a few of the faceting machines that are available to a prospective buyer, it is obvious that one may be confronted with a large number, each with its own good features, and conversely each with its less desirable features. The buyer must carefully weigh point against point in order to find a machine most suited to his needs. In order to assist in this decision, the following list of desirable features is offered. Any machine under consideration should have as many as possible.

1. Construction is of prime importance. The machine should be of smooth operation, and well machined and finished, so that it is quite presentable. A smooth finish is not really necessary, but it indicates the caliber of the manufacturer. Castings and parts need not be heavy as this makes it cumbersome. Conversely, extreme light weight makes for frailty and subsequent breakage. Compactness, within reason, is a good feature, as large and long portions wear rapidly and lose adjustment very quickly.

2. There should be interchangeable index gears. The best numbers are those that will allow the cutting of stones of 8 fold, 5 fold, and 6 fold symmetry. These are usually accomplished by the use of 64, 80, and 96 tooth gears respectively. These divisions are quite satisfactory when one attempts the more complicated cuts, but as an example, a 64 tooth index offers many chances for error in cutting a simple standard brilliant gem, as shown in Figure 6. The passing of the 32 index from most makes of machines is a real shame in the eyes of the authors. A low number of positions is ideal for the more simple cuts which are done by most faceters. The worst of the problem is that instead of 32, 40, and 48 indexes being offered by most manufacturers, there is a trend toward offering indexes with very large numbers of positions in order to combine two or more of the above. At least one machine comes standard with a 120 index, and the possibility of using the wrong position is quite high.

3. The protractor should have clear crisp divisions with a sharp pointer that may be easily read in any position. The pointer should not cover a large part of the protractor. The use of a magnifying glass, or other device is actually a detriment as it usually covers portions of the protractor that may need to be read.

4. The quill should be readily adjusted to 90° (horizontal) in order that facets may be cut on the girdle of the stone.

5. The elevating device for the mast or platform should work with ease, speed, and accuracy. If a vernier is present to assist in pinpoint accuracy, it should have its own vertical travel of at least one inch. The mast need not be calibrated, but it should be easy to return to a former point of cutting without undue searching.

6. There should be an adjustment for rotating the quill to either side of the index setting. This is known as a "cheater" (Figure 16) and will allow for the correction of minor errors. A cheater unit is designed to rotate the quill along its long axis, without disturbing the index setting. On the machine illustrated, this is accomplished by tightening and/or loosening the adjusting screws, A. This will rotate the complete quill, protractor, and index unit. The amount of rotation is shown on the scale, B, by the pointer, C. The scale is calibrated to either side of center, which is indicated as zero.

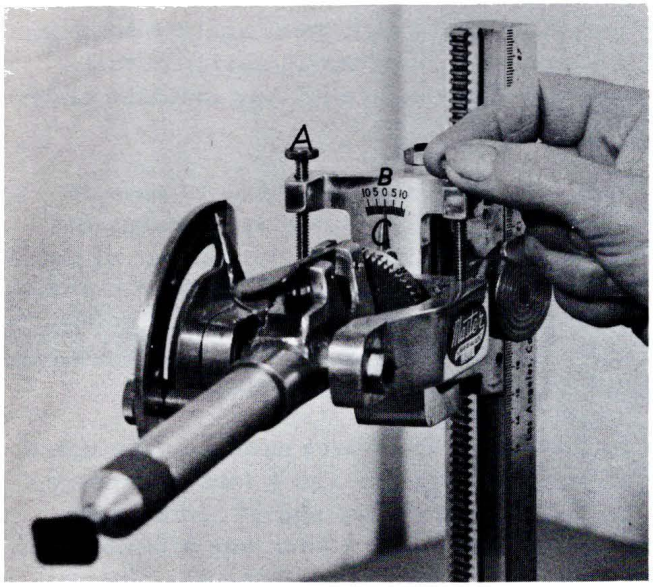

Figure 16. A Typical Cheater Unit. Photograph courtesy of M.D.R. Manufacturing Co.

The cheater is invaluable in polishing when it is found that the polishing lap does not exactly match the cutting lap parallel-wise. This situation is very common and a cheater is necessary to correct this and other difficulties.

7. The quill should allow the dopped stone to be removed and be replaced at any time during the cutting process. When it is replaced, there should be perfect alignment with former positions. This allows two situations. First, two or more persons may use the same machine without waiting for one to finish a stone. Second, it allows the removal of a troublesome gem for further treatment at a later date.

8. It is desirable that there be an easily adjusted device that will cause the machine to stop cutting at a pre-determined point. This is usually known as an "angle stop". The quill should not be easily sprung past the point of setting.

9. The arbor must run true, and be easily turned by a fractional horsepower motor. Some machines operate well with a 1/20 horsepower motor. A motor of over 1/4 horsepower is not advantageous, and causes vibration.

10. The machine, including the motor, should not be of great weight. Some of the best machines presently on the market weigh less than 50 pounds. There is no need to feel that weight makes for stability.

11. A lap wheel of six inch diameter is quite satisfactory and for usual cutting can be considered equal to an eight inch lap. Gems of slightly over 100 carats may easily be cut on a six inch diameter lap wheel.

12. Power to the lap wheel should be delivered through a small cross section V-belt, or a friction drive. The friction drive has the advantage of minor

speed changes without pulley or belt changes. The lap wheel speed, if constant, should run in the vicinity of 300 to 500 rpm. The lower speed is to be preferred.

13. If a machine is desired for portability, or use within a small space, it should have been constructed with this in mind. If the user wishes a machine to be permanently installed on a workbench, it should have brackets or other features to allow such installation.

14. The most desirable machine will allow the operator to cut or polish with the lap moving in either direction in relation to the work. Some machines will allow the dopped stone to be cut on either side of the lap without changing its rotation. This feature is invaluable in working with fragile or difficult to cut gem materials.

15. Any machine which has some type of protective material around the arbor nut may be considered superior. A neoprene or plastic coating around the nut is used by some manufacturers. The possibility of the gem striking the arbor nut is great, and chips are the usual result.

In the opinion of the authors, some machines are to be classed as excellent, others as poor, and a number as intermediates. It will be readily admitted, however, that in the hands of a proficient operator, any of the machines will produce good gems. The great difference in machines lies in the ease of handling. Some are difficult to operate. The prospective buyer might consider ease of operation as an important feature. This must be tempered in relation to his own manual dexterity. The wise buyer should make a real attempt to see a number of machines in operation by good faceters, not simply by salesmen. Best of all, he should operate a machine himself under the guidance of an experienced faceter.

Accessories

A faceting machine will be limited in scope unless it has a number of accessories. Some manufacturers include most or all needed accessories as part of the standard model. Others do not include them, but they may be purchased as extras. Still others may be purchased to suit the operator. This has a reflection in the price. The buyer must be cautioned to carefully consider price as a criteria in making the purchase. Many machines appear reasonable in price only to be found later that they are not complete. Nearly all the really good machines range closely in price. Any great deviation downward from such a figure usually denotes an inferior product.

The following may be considered as a fairly complete list of accessories. Each is discussed in later chapters.

1. An extensive set of cutting and polishing laps. Even though they may need to be purchased separately, they should be available expressly for the machine in question.

2. A device for scoring polishing laps. This does not necessarily need to be furnished by the manufacturer of any particular machine.

3. A very adequate supply of dop sticks of a variety of sizes and shapes. A minimum number might be twelve, more are desirable.

4. A V-block or redopping fixture for turning the half-finished gem. This is illustrated in Figure 92. If the dop sticks of any particular machine are other than 1/4 inch rods, the fixture must be made expressly for them. The fixture should have a wide, or an adjustable throat to accommodate large gems.

5. An attachment for grinding girdles may be very useful if the faceter plans to do preforming on the machine.

6. A book or booklet containing instructions for the machine is a necessity.

Additional Accessories

In order to operate a machine successfully, there are a number of items that will make the job easier. Those listed below may or may not be furnished by the manufacturer. As a faceter gains experience and refines his technique, he will add others.

1. A dopping wax of high tenacity and high melting point. The regular dopping wax used for cabochons ordinarily has too low a melting point.

2. A small jar of liquid shellac. This is an aid in dopping.

3. Alcohol and acetone to aid in removing dopping wax and cleaning the gem.

4. Flexible plastic "squeeze" bottles to hold liquids such as above.

5. Some type of small torch or bunsen burner as a heat source for dopping. The flame must be small; high heat is not necessary.

6. A supply of water for cutting laps.

7. Cellulose sponges for use as cutting lap wipers.

8. A bright light from a single close source. Incandescent bulbs are best. The small "high intensity" lamps are ideal.

9. A magnifying device, such as those worn over the head, is indispensible.

10. Small flat jars to hold polishing agents. Cosmetic jars are ideal.

11. Small artist type watercolor brushes to apply polishing agents.

12. Various types of polishing agents as outlined in Chapter XI.

13. One or two small pen knives and a supply of stiff-backed razor blades to facilitate wax removal.

Figure 17. The Optivisor Binocular Magnifier. Photograph courtesy of Donegan Optical Co.

14. A small note pad and pencil for notes during the cutting process. A work sheet is shown in Figure 69, Page 104.

15. Wiping cloths or facial tissues for cleaning the gem during inspections.

16. A can of light oil.

17. Gem or "diamond" tongs for handling finished gems. Figure 114, Page 247.

Claims Of Faceting Machine Manufacturers

As in any other field, the manufacturers of faceting machines extol the virtues of their wares. A good percentage of these tend to tell of the good points of their machines. Ease of handling, smoothness of operation, portability, unique features, precision, and completeness, are quite commonly called to the attention of the prospective buyer. These and other virtues are excellent selling points and are used by reputable dealers. How these features are explained to the neophyte is of importance. If they are only expounded as big words, without any clarification, they are of little use to the buyer and only tend to confuse him. Far too many manufacturers tend to overemphasize certain features without carefully explaining them.

Worse, many of them will use well worn cliches that have little meaning. The most common one is an invitation to compare their machine with others. If the prospective buyer is a new faceter, or does not facet, how can he be in a position to compare anything concerning faceting machines? If such a buyer were allowed to view a number of different machines simultaneously, it is doubtful if he could discern the good features from the poor features. This ability comes only after familiarity with faceting.

Another commonly used sales pitch is something to the effect that the machine is used by professionals. Usually the statement is not made directly, but is only an inference. First, we must decide who the professionals are.

What can truly be defined as a professional faceter falls into two classes. The first, is the individual in Germany, Israel, Brazil, or some other foreign country. He makes a living by cutting gems on a jamb-peg machine, and cannot afford to use intricate machines in order to achieve extreme accuracy. The other, mostly in this country, tends a group of semi-automatic machines. He is able to turn out a large number of gems in a short time. It then quickly becomes obvious that if the professionals did think that any machine being offered to the amateur was really good, he could not afford to use it. Instead, he would go on using his present machine because it offers speed. In the face of this, the seller inferring that professionals use his machine is either speaking of a very small number of individuals, or is confused as to the exact nature of a professional.

Another claim is, "acclaimed and used by the experts". If the one making the claim is queried as to who the experts are, the answer is somewhat uncertain. It should be quite obvious that most experts are quite satisfied with a machine they have used for many years, and have evolved a technique to fit it. They may think a new machine is good, but at the same time would be very reluctant to switch to it.

Some manufacturers spend much effort in comparing their machine to other

"unnamed" brands. The comparisons are very unflattering to the competitor. It must be understood that if the competitor's machine were of poor quality, as is inferred, it would soon disappear from the market. If it has not disappeared, it must be good. If this is true, why should a manufacturer degrade himself by criticising the other machine?

It would appear that the most reliable and reputable seller would be one that would admit that many other machines were good, and then carefully explain why he feels his machine is better. There is no reason why he cannot do this without degrading other machines, and himself as well.

The prospective buyer is urged to watch for advertising, verbal as well as printed, that carefully spells out the virtues of the machine in question without any unprovable claims. All of the many glowing statements will not make the machine work satisfactorily after it is purchased and is in the faceter's home.

A Faceting Machine As An Investment

When one decides to purchase a faceting machine, he must make a considerable outlay of money. The faceting machine may cost as much as three hundred dollars, perhaps more. To this may need to be added a grinding machine, a trim saw, and other accessories.

This equipment, in most cases, is bought expressly for one's enjoyment, but there are other factors to consider. Let us assume that the faceter cuts but two gems a week (many faceters cut that many in an evening); in a year, he will have about one hundred gems. Their value will vary, but most should be worth at least five dollars each, and some will be worth fifty dollars or more. If we add these very intrinsic values to the enjoyment (which cannot be priced) we find a very handsome return on an investment.

Chapter III

Laps That Cut

A FACETING MACHINE may be simple, or elaborate; crude in construction, or a precision instrument; but without suitable flat cutting wheels, known as lap wheels (or commonly, laps), few good finished gems can be expected from it. The laps must have a true surface and turn on a true shaft. These laps must have the surface coated or in some way impregnated with some sort of abrasive. Other laps must also be on hand, upon which some type of polishing agent may be placed in order to polish the gem. No machine is really complete without at least two of each type. Polishing laps are covered in Chapter IV.

Cutting laps must be as flat and true as is possible for two reasons. First, an untrue lap will cut irregularly, resulting in poor control of the facet size. Second, an untrue lap runs bumpy and may tend to shock some gems.

Various materials are used to make cutting laps, depending upon need. They may be made of a metal such as copper, brass, tin, lead, or cast iron, or possibly one of the plastic compounds, wood, or even wax.

ABRASIVES FOR CUTTING

Regardless of the material of which a lap is made, some sort of abrasive must be applied to do the actual cutting. These abrasives must be fairly hard, and certainly must be harder than the gem which is to be cut. The most commonly

used abrasives are carborundum grit and diamond powders; the latter being by far the most popular.

Carborundum grit, slightly over 9 in hardness, is commonly used in many other lapidary processes, and is available in grades designated by number; the finest grade, usually a flour-like powder, is designated about 1000. The sizes run to coarser with the number decreasing until 80 grit is about the size of fine sand. Any faceting use of carborundum grit, to be described later, is usually with finer grades.

Diamond Powders

For the greatest part, the faceter is concerned only with diamond as an abrasive. This is commonly called boart. It is the hardest known natural substance with a hardness of 10. In actuality it is many times harder than carborundum, as well as all gem materials except diamond. Diamond is graded in number designations the same as carborundum, but is graded to a much smaller size range, the smallest being 64,000 which measures below one micron in size. A micron is 1/1000 of a millimeter or approximately 1/25,000 inch. The micron size is also used as a designation for a number of sizes slightly above 1 micron. Table 6 shows the various diamond sizes and their general uses. The smaller micron sizes are used almost exclusively for polishing and are covered in Chapter IV.

The diamond sizes ordinarily used for facet cutting run from 1800 (about 10 micron) to 100 grit as the largest. Larger sizes are used in diamond saw blades. A faceter seldom has use for 100 grit diamond except for rapid removal of material from a very large stone, and will confine his greatest use to sizes of 200 for general rough cutting; 400 and 600 for roughing out small gems; 800 for ordinary finishing preparatory to polishing. At times one may use 1200 or 1800 for a superfine finish before polishing, especially on small or soft gems. Most faceters do not equip themselves with this many grades, but narrow their needs to about three laps. These can easily be designated as coarse, medium, and fine. All further discussions shall use these designations. Table 6 lists these designations and the various grit sizes. The actual decision as to the grit size for each designation is, of course, up to the individual.

The authors have found the following sizes to be most satisfactory: coarse, of 100 grit; medium, of 200 grit; fine, of 800 grit; and extra fine, of 1200 grit. A medium gives fast removal of material when roughing out a gem, and both the fine and extra fine give a good surface which is easy to polish. The above selection of diamond sizes is recommended as it has been found that it will safely cut stones of far below one carat to over 100 carats. If gems over 25 carats are not attempted, the coarse lap may be dispensed with. This size gem may be cut on the medium lap, but a proportionately greater time is necessary before the fine stage is reached.

TYPES OF CUTTING LAPS

One common facet cutting lap in use is the charged copper lap, Figure 18. Actually the lap is a high copper bronze. Brass and other metals have been used, but they are not as satisfactory. The copper lap has been popular with faceters as it may be readily purchased either impregnated with diamond, or simply as pure metal and impregnated by the user.

TABLE 6

DIAMOND POWDER GRADES

U.S.B.S. Grade No.	Equivalent Grit Size	Micron Range	General Purposes for Faceting
½	50,000	0-1	Specialized super polish
1	14,000	0-2	Fine polishing
3	8,000	1-5	Medium polishing*
6	3,200	4-8	Rough polishing*
9	2,000	6-12	Fine finishing (extra fine)
15	1,200	8-22	Fine finishing (extra fine)
20	800	15-30	Meduim finishing (fine)
30	600	20-40	Rough finishing
45	400	30-60	Fine facet cutting
60	325		Medium facet cutting
90	230		Heavy facet cutting (medium)
120	120		Heavy facet cutting*
150	100		Rough facet cutting (coarse)
180	80		Thin diamond saw charging
250	60		Very rough facet cutting (ex.coarse)
400	40		Large diamond saw charging

The above are established by the U.S. Bureau of Standards for grade number, grit size, and micron range.

Grit sizes are based upon the number of openings per square inch in a screen. Natural diamond boart on the market today is seldom screened, but instead is graded by a floatation process. All natural diamond is checked microscopically to guard against the presence of long slender pieces. The general purposes listed above have been revised by the authors. Those marked * are seldom used by faceters. The size designations in () are used in the text to denote general lap classifications.

Adapted from a table courtesy of
Industrial Diamond Powders, Inc.

In recent years more permanently charged laps have appeared on the market. One type is unique in that the diamond powder is covered by metal which is electroplated around the grains, and onto a suitable base. Permanently charged laps have many advantages. First, the boart is evenly distributed over the lap surface; a somewhat difficult task when hand charging. Second, the individual grains are completely and tightly surrounded with bonding agent in such a way that they cannot turn under use as long as the bond is intact. These two factors contribute to a long life and great smoothness in cutting.

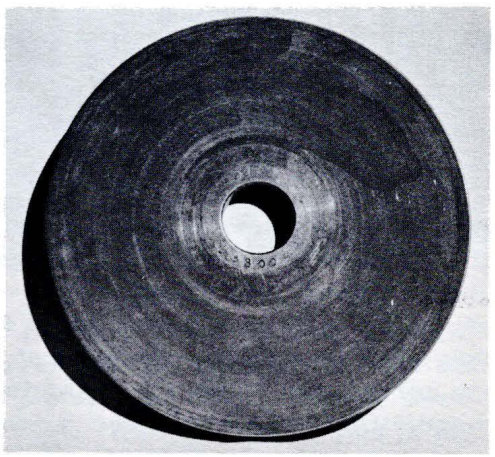

Figure 18. A Hand-charged Copper Cuting Lap.

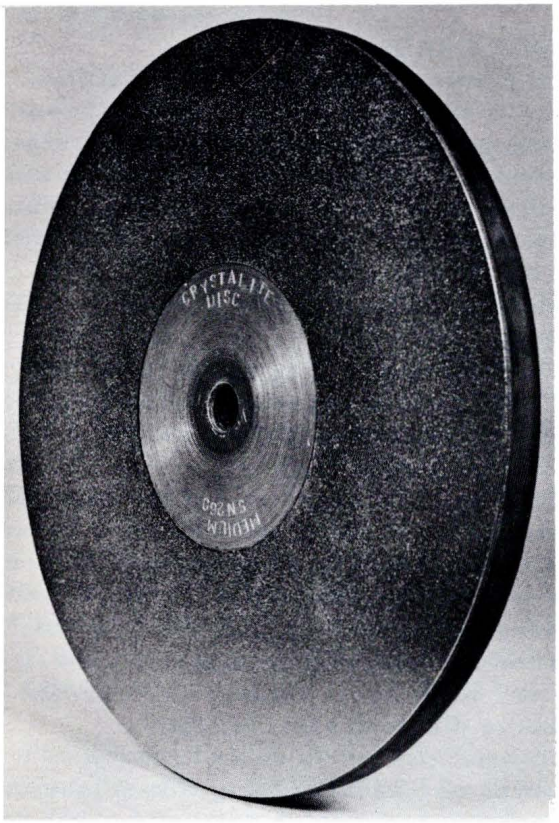

Figure 19. The Crystalite Diamond Cutting Lap. Photograph courtesy of Pacific Test Specialties.

The cost of these permanently charged laps (Figure 19) may be considered high, but on a cost-per-stone basis, the price is relatively low.

Hand Charged Copper Laps

Copper laps must be recharged at intervals. The interval between charges will depend upon how many stones have been cut, and their relative sizes. A charge will remove only so much material, depending upon a number of factors, but large stones will more quickly dissipate the charge.

The dulling of a copper lap is the result of a number of factors working either independently or together. First, the grains are pushed downward into the metal. This sinking of diamond into the base metal is a normal situation, but it can be greatly accelerated if heavy pressure is exerted during the cutting process. Second, the individual grains have a tendency to roll within the socket in which they lie. Great pressure will also assist in this rolling. If this turning of the particle results in a flat surface being uppermost, the cutting efficiency is lowered.

Third, in spite of its great hardness, diamond grains do exhibit attritious wear. Diamond is usually many times harder than the gemstone, but it wears away in an inverse proportion. Further, diamond exhibits a pronounced cleavage in four directions, and it is very possible that some particles will have a cleavage plane at right angles to the lap surface, and if so, the particle will tend to cleave and fray off. These factors combine to create what the faceter calls a dull lap.

Determining The Point Of Recharging

Hand charged copper laps exhibit an interesting cutting pattern. When freshly charged they cut very rapidly, but after one or two stones have been cut they settle down to a quite smooth and somewhat slower operation. Finally, the lap will begin to cut slowly. Continued use will finally result in an almost complete cessation of progress. For the sizes of 800 and smaller, a scratching of the surface of the gem will become apparent. This is the result of most of the grains having been driven deeply into the lap surface, with a few still projecting above the surface. As the more deeply embedded grains are but little exposed, they produce a very smooth facet surface, with the normal sized grains scratching across this surface. Obtaining a polish on this type of surface is slightly more difficult than normal. When laps reach this point, recharging is necessary to achieve the greatest efficiency.

Recharging A Copper Lap

The embedding of fresh diamond boart into the surface of a metal lap is known as charging, or placing a charge on the lap. It must be done in such a way that the individual grains have more than half of their bulk below the lap surface, and that metal is crimped over part of the upper half of each grain. This embedding should be accomplished with a minimum of crushing of the grains.

Placing The Diamond On The Lap

In any charging method, the first act is to evenly spread a measured amount of diamond powder on the lap. This is best done using a medium weight oil such as mineral oil or olive oil as a carrier for the diamond. Mineral oil is to be preferred as it has no odor, and will not become rancid upon long storage. Only a very few drops are needed for a charge.

To recharge a six inch diameter lap, about 1/3 carat of diamond is necessary. About twice this amount is necessary for an eight inch diameter lap. For initial charges of new laps, at least double these amounts are necessary. The measured amount of boart is placed in a small round bottom container. A small cosmetic jar will do nicely. Upon the small pile of powder place about six to twelve drops of oil. The larger amount may be needed for coarse grits, or to suit the individual. The mixture, after being stirred, should be markedly thicker than the pure oil, but should not be pasty.

With the tip of the finger, or a small brush, pick up a small amount of the mixture and place at measured intervals over the lap surface. Continue placing the mixture over the lap until all the amount allocated for the lap has been transferred to it, as shown in the left of Figure 20. With sweeping motions, spread

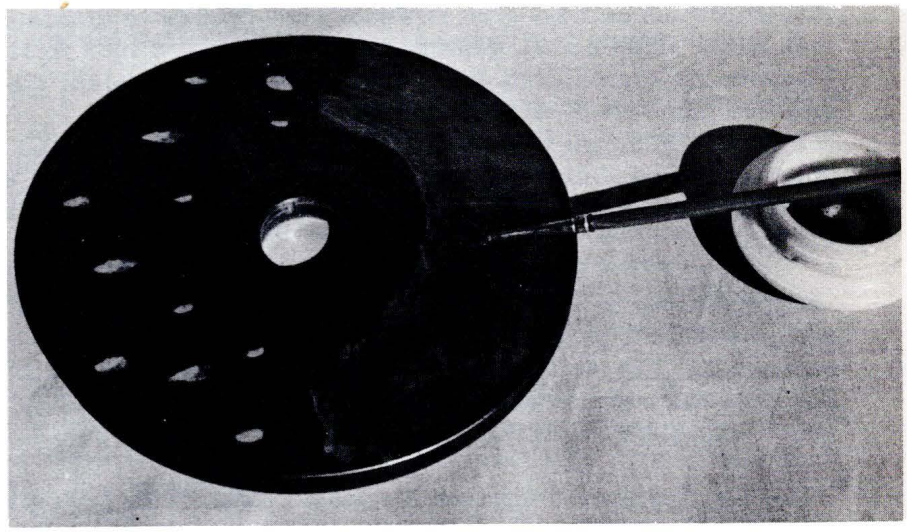

Figure 20.
Applying Diamond Boart.

the diamond until it is evenly distributed over the lap. Be certain it is spread well out to the edge of the lap. It is not necessary to closely approach the center portion, as little work is done here. The job of spreading cannot be overdone, and a bit of extra time here is well worth it. When the spreading is complete, as in the right of Figure 20, the lap is ready for the embedding of the grit. The surface should appear a bit frosty. Too much oil may tend to float

the individual grains, and will be messy in later stages. Insufficient oil to completely coat all particles may result in poor distribution.

If more than one lap is charged at a time, start with the smallest grit size first. Completely spread and embed the smaller grit before going to the next larger size. If this sequence is not used, contamination may result. Use a separate jar and brush for each grit. The policy of charging more than one lap is a good one, and the above order of work will be perfectly safe.

Embedding The Diamond Powder

A satisfactory method is forcing in the diamond with a metal roller, such as is shown in Figure 21. The roller is an ordinary ball bearing that is easily

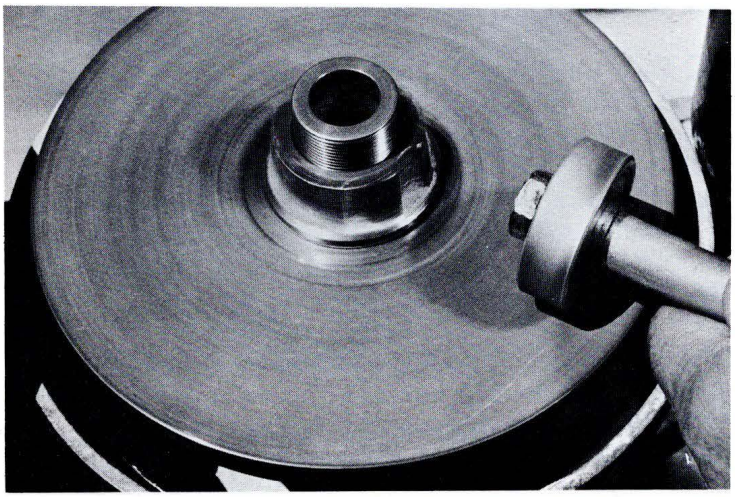

Figure 21.
Charging a Diamond Lap with a Metal Roller.

obtainable. The best size is about 1 1/2 inches in diameter, by about 5/8 of an inch wide. The center hole should be about 5/8 inch to take a dowel for a handle. The outside diameter is not of real importance except that a greatly larger or smaller one will be difficult to handle. The width is of importance; less than 1/2 inch is difficult to hold flat to the lap, and wider than 5/8 inch covers too much area and thus is bearing against a great amount of diamond boart. Enormous pressure may be needed to embed the larger grits if the charging wheel is too wide.

After the lap is spread with diamond in oil, it is placed directly upon the faceting arbor. The lap is turned at normal speed with the roller held at the edge of the lap. The roller is held flat to the lap and moved slowly toward the center and then back to the edge (Figure 21). A coarse grinding sound will be heard, which will soon change and quiet down to a rolling sound.

The first pressure exerted should be light, with pressure increasing as the sound changes. The face of the ball bearing is very hard metal and the diamond can do no more than nick it. This hard surface can crush the diamond if too much pressure is exerted until the individual grains are at least partially embedded. After the particles are embedded, which may call for as many as six passes over the lap, the final run at heavy pressure will crimp the metal around the grains, holding them firmly.

Starting at the edge of the lap prevents boart from being slung off. Actually,

there is little slinging under ordinary conditions as diamond has a great affinity for oil. If too much oil is used it may be slung from the lap taking diamond with it.

Laps charged with a metal roller cut very rapidly, and the charge, in the experience of the authors, will last longer than any other method tried. The method has one drawback in that some of the grains may be crushed. Even if quite gentle pressure is first applied, there is undoubtedly some crushing. The smaller particles that result are also embedded, and the only loss is in grain size.

Hand Charge And Permanent Charge Laps Compared

The faceter has available to him a number of brands of permanently charged laps, as well as the hand charged type described above. Each has good features, and each has some drawbacks. All things considered, the permanently charged cutting lap has some pronounced advantages.

The greatest virtue of the permanently charged lap is that the grains do not easily sink into the backing material and thus constantly present the same number and size of grits throughout their useful life. This results in a very smooth facet surface, making the steps toward polishing much easier. Scratching may appear at intervals, and is usually the result of outside contamination of other than diamonds. This usually can be removed by scrubbing the lap with a grit-coated sponge. Misuse of the lap, such as running it dry, will result in clogging and actual physical breakdown of diamond or the lap itself.

The directions of the manufacturer should be carefully followed. The life of these laps will depend upon use, both as to time and conditions of operation, but the period is comparatively long. It is very difficult to determine how many carats of gems any lap wheel will cut. It is quite obvious that 100 one carat gems have vastly more surface than a single 100 carat gem. Any well made permanently charged lap should outlast many hand charges of a copper lap.

The authors have found that the permanently charged laps do not cut as fast as newly hand charged laps of comparable grits. This is in part due to the constancy of grit sizes as discussed previously.

Evidently the greatest deterrent to the use of permanently charged laps is the initial cost. The cost of the coarser grit sizes is higher than the fine sizes. In the final analysis, the faceter who refuses to buy on the bases of initial cost is missing the point.

Even if we assume, on the basis of time and number of carats cut, that the hand charged lap proves to be cheaper; the advantages of the permanently charged laps should make them the better buy. Convenience and a very smooth facet surface should be worth considering.

All cutting laps charged with diamond boart exhibit an interesting behaviorism --after a period of time they appear to contain a coarser grit. All particles of diamond boart, whether they have been crushed or are synthetic crystals, exhibit a globular or angular shape with the greatest bulk of the particle at or near the center. When particles of this type are embedded in a lap wheel, the portion of each particle that does the first cutting is quite small in relation to its greatest diameter. If the piece of boart is held quite firmly (regardless of

the holding method) it may continue to cut over a long period of time.

As noted previously, the boart particle wears away in inverse proportion to the material being cut, and some of it is ground away. Finally, it is very possible that, after a period of time, the boart particle may be worn away. Now it presents a much larger surface to the gem material being cut, and any scratches it will make are larger than when the lap was new. (All grit particles remove material by making scratches.) This feature, in all probability, at least partially accounts for the behavior used to tell the point of recharging, as noted in a previous section.

It must be emphasized, however, that the apparent grit enlargement is not a real problem. The "new" grit size is not near the next larger standard grit size, and can usually be ignored. The only time it may become a problem would be on the extra fine lap while cutting a fragile material. Larger scratches might be difficult to polish out.

The Use of Loose Grit

Some faceters make a practice of using loose grit when cutting gem materials very sensitive to impact. Regardless of how a copper lap is charged, the surface will subsequently never be as perfect as that of a freshly machined disc. As copper, or bronze, is a relatively hard metal, this uneveness transmits an impact shock to the material being cut.

Loose grits are applied in small amounts to laps of either lead or tin, with lead usually being preferred. These metals are soft, and a gemstone striking any slight protuberance on the lap surface is not greatly shocked. Another type of lap used with loose grit is one of the plastics. Vinyl and micarta (the laminated type used as counter and table tops) are preferred. These plastics are usually quite thin, and must be cemented to some sort of rigid backing.

The grit, usually carborundum of the finer grades, will slightly embed in the lap surface with a resultant gentle cutting action. Soft or very friable gemstones are usually cut with 600 grit or finer, and at as slow a lap speed as is possible. As a rule, the method is satisfactory, but very messy. The grit has a tendency to sling off the lap, and much of the equipment is soon covered with it. After loose grit lapping jobs are completed, a scrupulous cleanup is necessary.

It appears that the permanently charged laps of the finest grits should do these jobs safely, and they should soon replace the use of loose grits except for very unusual circumstances. The cutting of such sensitive gemstones is covered in Chapter XII.

CUTTING LAPS MUST BE LUBRICATED

Regardless of what type of lap is used, it must be lubricated. For charged diamond laps, regardless of type, water is almost universally used. Most faceting machines are equipped with some sort of device that allows water to drip onto the lap. If a machine is not so equipped, it is a simple matter to rig up a can, some tubing, and some sort of valve that will control the flow. In the case of permanently mounted machines, tapping the household water system affords the convenience of a constant supply. Machines that are equipped with an outflow device on the splash pan offer no drainage problem.

Figure 107 shows a sponge held by a clamp attached to the machine so that it is in place during cutting, but may be removed for other operations. This sponge (the cellulose type is best) is a real necessity. It should be placed so that it may be lowered onto the lap, directly under the water supply. Its action is three-fold. First, it evenly spreads the water over the working surface of the lap, thus insuring that both lap and the stone are cool. Second, the sponge acts as a trap for the dust-sized particles of the gem that have been removed during the cutting. If these were not removed, they would find their way into the spaces between the diamond particles and the lap base, and by so surrounding the diamonds, would lower the cutting efficiency. Third, the sponge also acts as a trap for excess water. This excess water piles up behind the sponge and is thrown by centrifugal force from the edge of the lap, and carries with it the cuttings lying behind the sponge.

The correct amount of water applied to the lap depends upon the type of lap, the particle size, the type of gem being cut, and personal opinion. Soft gems cut away much faster and thus create greater amounts of cuttings. Regardless of the situation, too much water cannot be used, and an insufficient amount could be very detrimental to either gem or lap. Experience will soon determine the amount needed.

Oil As A Lubricant

There is little argument against the fact that with diamond, a light oil such as kerosene is a superior lubricant. Some faceters use kerosene to the exclusion of water, but they are constantly confronted with an oily and odorous mess. There is undoubtedly a greater cutting efficiency using oil, but the inconvenience does not seem to be worth it.

Nevertheless, kerosene has a definite place as a lubricant. If one uses loose grit as described previously, kerosene is practically a necessity. On very rare occasions, the frictional drag when using water will cause a gem to chatter on a lap. This chatter may be due to the gem picking up particles of copper with the gem becoming partially plated with copper. The use of kerosene will greatly assist in controlling this behavior. As far as is known, this is unique to copper laps, and is of rare occurrence.

Contamination Of Cutting Laps

All laps should be used and stored in such a way that they are protected from contamination with foreign particles. The best storage position is vertical in order to minimize particles coming to rest on the surface. Washing a cutting lap before use is not mandatory, but cleanliness really cannot be overdone.

No matter how carefully one uses or stores laps, stray pieces of grit or other substances may become embedded in the surface. This happens with greater frequency with cutting laps, but is a much greater problem when it happens to polishing laps. It is obvious that a large diamond particle embedded in a coarse lap would be of a lesser consequence than a medium sized grit embedded in a fine lap. Scratches induced by the former can be easily cleaned off with a fine lap, but scratches of the latter cannot be polished out without difficulty. Good practice demands that contamination such as the above must be removed.

Removal of Contamination

When contamination of a cutting lap has been definitely determined, try to locate its approximate distance from the edge of the lap. This is quite easy by noting the position where scratches are produced. Leave the lap on the arbor and dry thoroughly. Take a piece of clear quartz crystal that either has a smooth crystal face or a previously lapped surface, and place it on the dry turning lap. If the position of the contamination is known, place it in that area. If the exact position of the contamination is not known, scratches appearing on the smooth surface of the quartz will help to locate it.

Running the lap dry will remove particles from the quartz, but they will not move far from the point where they were cut away from the quartz. The cuttings will lie just to the rear of the particle of contamination, leaving a "tail". This tail is of a grey color and can easily be seen when the lap is not in motion. A small amount of probing with a sharp pointed knife at the front end of the tail should dislodge the particle. A second try with the flat quartz will determine whether or not the operation was successful. The small blemish put into the lap surface by the knife point will be of no consequence and will disappear with use.

Chapter IV

Laps That Polish

POLISHING LAPS usually are of the same general size and thickness as cutting laps, but are made of much softer materials. These materials include tin, typemetal, tin and lead (ordinary tinners solder), pewter, lead, and other metals. Some of the plastics such as plexiglas (incorrectly called "lucite"), vinyl, and the laminated plastics mentioned in Chapter III are also used. Modern phonograph records do very nicely for a supply of vinyl, but they must be cut down to size. Various waxes, with beeswax being the most popular, are used for very soft gems and are discussed in Chapter XI. Wood and felt laps have been used for some gems.

ORDER OF POPULARITY OF POLISHING LAPS

There is very little disagreement among faceters about "lucite" being the best lap for quartz gems. Most faceters also use this lap for the beryls, but some of the metal laps appear to be better. Concerning the metal laps, there is much controversy as to which lap is best for any given gemstone. Part of this situation arises from the fact that natural gemstones vary in polishing characteristics, and a lap that will work for a gem material from a given mine may not work for another like gem from a different mine. It is also very possible that gems from the same mine may show this tendency. Coupled to this is the fact that the use of polishing powders varies among faceters. In reality when they argue the merits of polishing methods they may not be talking about the same thing. Polishing powders are discussed in Chapter IX.

The metal lap that has for many years had the greatest popularity is one made of pure tin. Second in popularity is typemetal, a mixture of tin, lead, antimony, and traces of other metals. The balance of the metal laps can be placed in a third group, with each having about an equal number of users.

Tin as a pure metal is costly and usually not readily obtainable if one wishes to make his own laps. Typemetal on the other hand is readily available at reasonable prices from print shops. The practice of making one's own laps is fairly common, and if the faceter is capable of doing so, it is recommended.

The experience of the authors does not exactly follow the above order. It has been found that tinner's solder (50% tin and 50% lead) will normally polish, with Linde A as an agent, more than 75% of the usual gems. Tin/lead is a comparative newcomer in the faceting field and this probably accounts for its lack of popularity.

Recommended Polishing Laps

The following laps and order of importance are recommended. If the faceter wishes to have a minimum number of polishing laps, "lucite" and tin/lead will carry him at least through the stage of polishing the commoner gems. When he wishes to try the unusual, other laps will be in order.

A common fallacy with some faceters is that one lap and one polishing agent will polish all gems. The authors have found this not to be true, and can attribute the belief to some faceters giving up on certain stones when their "favorite" lap did not do the job. On the other hand, however, an assortment of every possible lap and every conceivable polishing agent is not necessary. Only a highly experienced cutter who will work on any gem would need such an array.

If one wishes to add laps to the basic tin/lead and "lucite", the following list is offered. The first choice should be typemetal, followed by tin, lead, and finally pewter. The authors' experience with pewter has shown it to be little different from typemetal. Pewter is difficult to obtain, and there are a number of formulas for it, making any results somewhat unpredictable.

Table 7 lists the usual lap materials in order of hardness. Some mixtures, such as tin and typemetal are included as they appear from time to time in the literature. Each has a place, but only seldom will the average faceter need these specialties. The principle of lap hardness in relation to gem hardness is covered in Chapter XI.

Lead, though a rarely used lap, deserves some special discussion. It quite often is essential in polishing such gems as apatite, peridot, and fluorite. The surface of lead oxidizes very rapidly, and the oxide is harder than the pure metal. After each use, a lead lap should be coated with a light grease (vaseline is excellent), and the lap stored in this condition. Otherwise it may need to be completely resurfaced before any subsequent use. These features are a nuisance, but on many occasions it has been found that only lead would accomplish the polishing of a difficult gem. Other laps need not be protected when not in use except from contamination by dust and grit.

Lead laps have another very annoying characteristic. The metal has a tendency to crawl under the pressures of polishing. This produces slight ridges, and the lap becomes bumpy. To correct this, some manufacturers add a small

TABLE 7

COMPARATIVE HARDNESSES OF POLISHING LAPS

Material	Hardness	Components
Copper	3.0	pure rolled copper
Zinc	2.5	pure zinc
"Lucite"	2.0	an acrylic plastic
Typemetal	2.0	lead, tin, antimony, copper
Tin/lead	2.0	lead, tin - equal amounts
Pewter	2.0	lead, tin, others - (variable)
Tin and typemetal	1.8	
Tin	1.7	pure tin
Lead	1.5	pure lead
Vinyl	1.0	a plastic
Beeswax and carnauba	.3	90% beeswax, 10% carnauba wax
Beeswax	.2	pure beeswax

Coupled with the above hardnesses it is difficult to correlate toughness. This enhances the effect of hardness. Copper is a very ductile metal and thus quite tough. Zinc and tin are somewhat brittle. Lead is tough, and adds this toughness to its alloys. The plastics are relatively tough in about the same proportion as their hardness. The waxes are surprisingly tough.

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amount of antimony or bismuth to produce a slightly harder alloy. Bismuth and antimony are difficult to obtain in small amounts, and for those that make their own laps, the addition of a 1/2 to 1 percent of tin will do nearly the same job. These alloys will not polish as well under some conditions as the pure lead lap, but this should not be of consequence except on rare occasions.

"Lucite" as a lap also deserves some discussion. It has one annoying feature that must be guarded against, that of generating excessive heat. The tenacity and toughness are quite high, even though the hardness is reasonably low. This tenacity creates terrific drag against the facet being polished, which in itself is a very desirable feature. The amount of heat that is generated in the process is usually not more than the gem can stand, but any type of dopping wax that has a low melting point will usually soften with use on a "lucite" lap. The technique calls for either frequent cooling, along with a constantly damp lap, or the use of a dopping wax of a melting point of at least 200 degrees Fahrenheit. This rules out most of the dopping waxes used for cabochon cutting.

THE POLISHING LAP SURFACE

Polishing laps usually need to have the lapping surface roughened before they will work efficiently. The roughing of the lap surface is known as scoring. This is a process in which definite scratches are introduced onto the lap surface.

The Reasons For Scoring

There is a three-fold need for scoring of polishing laps. First, with a

perfectly smooth surface, the polishing agent will easily be thrown from the lap by centrifugal force. The individual grooves of the scoring will greatly assist in holding the polishing agent on the lap.

Second, a perfectly flat lap surface and a like facet surface can quickly make very close contact, generate a large amount of heat, and at the same time tend to exclude the polishing agent, with little or no polishing being accomplished. If this situation is allowed to continue, the exclusion of material between the two surfaces will tend to be much like lapping without water, and cracked gems can easily result.

Third, a perfectly smooth pair of surfaces, as described above, will have a partial vacuum created between them at ordinary polishing speeds. This vacuum has some very adverse effects on polishing. There is always a tendency, regardless of the lap surface condition, for the polishing agent to pile up behind the stone. Any small irregularities of the edge of the facet in contact with the lap will tend to funnel the polishing agent and force it to pass in a line under the facet. The vacuum will greatly augment this action. When polishing agent is forced under a facet, it is submitted to great pressure. The individual grains tend to roll into balls which, under these conditions, act as if the ball were now a single large piece of grit and thus cause a deep scratch. This effect, known as "Aggregation and Flow", was first reported by Sir George Beilby* and is the worst behaviorism of a smooth lap. The aggregation and flow effect is further covered in the chapter on polishing.

The presence of scores or scratches in the surface of the lap will greatly reduce the forming of a vacuum. Any polishing agent particles that get under the facet will tend to lie in the scores and be dragged past the facet as individual particles.

Methods of Scoring

There are a number of methods of producing the scored surface. The results are slightly different and each has good features. The faceter should try as many of the methods as possible and settle on the one that best suits his needs and technique.

Radial Scoring

The most common type of scoring is known as radial scoring. It consists of grooves running from the center to the edge of the lap. It is usually done by drawing some sharp instrument across the lap and placing the scores as close together as is possible. A common scoring tool is an ordinary pocket knife blade. This is satisfactory, but the job is long and tedious. A knife makes a quite deep score which is an advantage under most conditions, and thus the scores may last a longer time under use.

A better instrument for radial scoring is a 3/4 or 1 inch section of an ordinary hacksaw blade of about 24 teeth per inch. The blade section is drawn across the lap as shown in Figure 22. The scoring here is rapid, with even depth, and has the advantage that the lap will not become bumpy as may be the case with the knife blade. Frequent rescoring is necessary with this method.

* See - Revised Lapidary Handbook, Howard; page 113

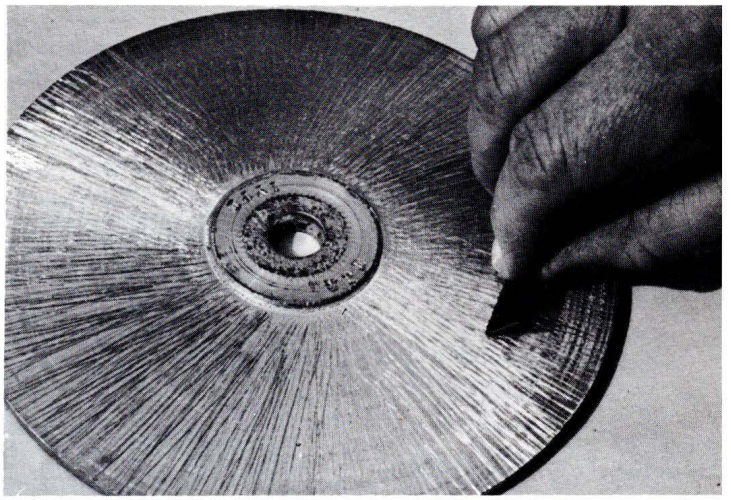

Figure 22.
The Method of Radially Scoring a Polishing Lap.

The great advantage of radial scoring is that it is easily accomplished with simple tools. The surface produced is easily comparable to more elaborate methods.

Concentric Scoring

The other method of scoring is known as concentric scoring. In this case the scoring is induced while the lap is turning and the scores lie in parallel rings over the lap surface. A knife blade or the piece of hacksaw blade may be used with this method. The knife blade is not too satisfactory as there is a great tendency for it to get caught in a previously made groove and thus cut a deep channel. The hacksaw blade works well, but heats rapidly, and unless fitted with a suitable handle is very difficult to hold.

The best method of concentric scoring is to use a tool such as shown in Figure 23. This tool is a single cutter from a knurling tool used on lathes in a machine shop. For use in faceting it is fitted with the handle as shown. The

Figure 23.
Using the Concentric Scoring Tool.

tool is moved from the outer edge of the lap toward the center and vice versa. The scores produced are fine, very close together, quite evenly distributed, but are somewhat shallow. They do not hold up as long as those of the radial method, but rescoring can be quickly and easily accomplished. This is the favorite method of the authors. A comparison of both scoring methods is shown in Figure 24.

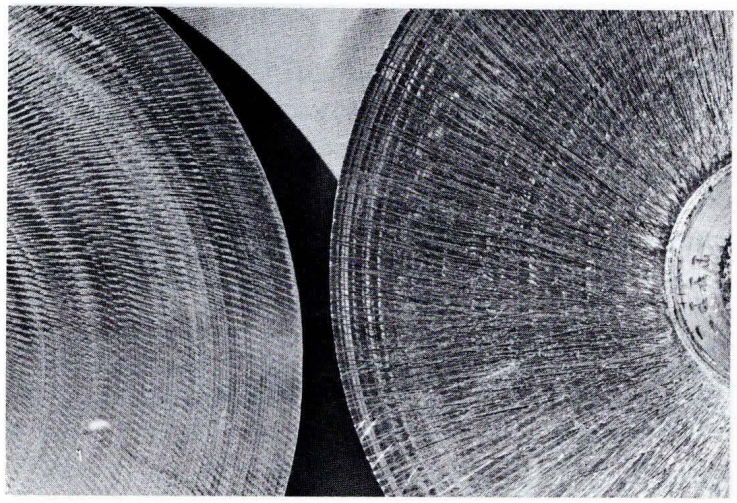

Figure 24.
Comparison of Scoring Methods.

The lap on the left has been scored with the concentric scoring tool. That to the right was scored with the section of hacksaw blade.

Use Of Scoring Tools

Nearly all polishing agents are harder than the metal of the scoring tools, and the tool is worn if the lap is not first cleansed of polishing powder. In practice it is not possible to remove all traces of polishing powder, and thus the tool receives some wear at best, but a thorough cleaning can help to minimize wear. With the knife blade and the section of hacksaw blade this can be of little concern as sharpening of the knife or the use of a new blade section can restore the original situation. With the rotary scoring tool, its life will depend upon the frequency of use and the cleanliness of the lap. A worn tool must be discarded.

Metal laps are soft and the tool readily cuts into the surface. The "lucite" lap is entirely another matter. The tenacity and toughness referred to previously necessitates heavy pressure in order to induce even quite shallow scores. A greater number of passes over the lap is necessary before the desired surface is attained. Other plastics such as vinyl are easier to score and somewhat resemble the metals.

Smoothing the Top of the Scores

Many authors suggest smoothing the upper edges of the scores before starting to polish. The usual method is to use a flat piece of agate and lightly pass it over the turning lap. This will remove the slight bumpiness of deep scoring caused by the knife. In the case of the rotary scoring tool used concentrically, there appears to be no real need for smoothing. The act of polishing does the job nicely. The first two or three polishing passes on a newly scored lap may collect a few bits of lap material dislodged by the scoring, but these are easily wiped away during the usual cleansing of a facet before inspection.

LAP THICKNESS

The usual polishing lap thickness is about 1/4 inch. A lap of slightly greater thickness is advantageous. Laps under 1/4 inch in thickness are perfectly useable also. Metal laps that are too thick, in the vicinity of 1/2 inch, can be heavy and cumbersome. Those of extreme thinness can become bent if dropped. Thin laps of "lucite" are very serviceable, and as to be seen later might be preferred to thicker ones. These laps do not warp unless they are overheated or stored incorrectly. There is an advantage to using polishing laps about 3/8 inch in thickness, as they can be resurfaced a number of times.

Resurfacing Of Polishing Laps

After a period of use all polishing laps will become grooved about half way from the arbor hole to the edge. This is the region that most polishing activity takes place. This condition can be determined when the lap polishes only the ends of long facets. A small amount of correction on the metal laps may be obtained by the use of a razor blade as described in a later section on removing of contamination (see Figure 25). This method may actually lead to greater trouble if not done with great care. The practice of truing a lap surface by any other means than a lathe is not recommended. Few people can improve such a surface with any kind of hand tool, and trying to do so usually ends in the lap finally going to the lathe, where it should have gone in the first place.

Never try to resurface a polishing lap with abrasive cloth or wheels. It is theoretically possible to resurface a lap by this method, even though it would be tedious. It is impossible to keep abrasive particles from being embedded in the lap surface.

Any good machinist with a true lathe can easily remove the necessary amount of surface in order to restore lap flatness. It is necessary for the machinist to completely understand the kind of material of which the lap is made. Most of the metals require a different lathe speed or a different tool position. Resurfacing of "lucite" laps is possible, but the machinist must understand the material. A high lathe speed and the removal of only a very small amount of material appears best. Because of this difficulty of resurfacing "lucite", the thinner discs are recommended as they can be discarded when worn.

The surface of a lathed lap must be smooth and without chatter marks, but slight ridges are not necessarily detrimental since scoring will produce a rougher surface.

CONTAMINATION OF POLISHING LAPS

Polishing laps should be stored in the same general way as cutting laps, but not adjacent to them. A plastic bag to hold each lap during storage is an excellent practice. A thorough washing before each use is an excellent way to start any polishing sequence. Whether or not the lap is washed after use and before storage is a matter of preference.

Most faceters experience scratching on occasions during polishing, and the tendency is to suspect contamination of the lap. In the greatest number of cases the problem can be laid directly to aggregation and flow. There is, however, always the possibility of actual contamination, and when this has been determined to exist, it must be removed.

Removing Contamination

Ordinarily contamination may be removed by scraping the lap surface with a razor blade as shown in Figure 25. The blade is held in line from arbor hole to edge, and tilted about 15° from vertical, so that the edge of the blade points toward the direction of turning of the lap. This will tend to scrape off a small amount of the lap surface, and it is assumed that the contamination will go with it. A number of passes across the whole lap surface, with cleaning of the razor blade at frequent intervals, should do the job. Even if the exact location of the contamination is known, the whole surface should be scraped in order not to destroy the lap flatness. There may be more than one particle on the lap, and the others will also be removed.

Figure 25.
Removing Polishing Lap Contamination.

A position at one place on the lap should be held for a few seconds, the blade cleaned, and the scraping changed to another area. Do not attempt to move the blade to another position while in contact with the lap, as it may catch and damage fingers or lap, or both.

If the above method does not work, try the dry method using a quartz crystal as described in Chapter III for removing contamination from cutting laps. The quartz crystal must be flat, and care exercised in placing it on the turning dry lap. When all else fails, the lap must be taken to a lathe and resurfaced as was previously described, or the lap must be discarded.

Recently, some commercially charged polishing laps have been introduced. They are used by adding only water, and as a result should help to lessen the problem of aggregation and flow. When they become more popular, these laps will have the ultimate effect of reducing some of the polishing problems that faceters have experienced.

Chapter V

Choosing Materials

THE AMATEUR FACETER should feel quite happy for the choice of fine faceting material that is available to him. This may seem to be an unusual statement when it is next admitted that the finest material, almost without exception, makes its way directly to the professional gem cutter. In actuality, the gem material that the professional might consider to be of second grade is but slightly inferior to that which he prefers. The great difference between the two grades is in the size of the individual pieces, and their perfection and intensity of color. Seldom does one see large flawless pieces of faceting materials, or those with the most desirable colors. There is no question that the amateur may feel chagrined about the lack of availability of fine colored gem material, but the absence of large sizes should not bother him greatly as he probably could not afford them.

MANY GEM MATERIALS ARE AVAILABLE

Some of the rare gem minerals are very difficult to obtain in any size, and the price is usually out of reach for most faceters. Regardless, there is a wealth of fine gem material, commonly called faceting rough, constantly on the market at reasonable prices.

Most amateurs can spend a number of years cutting the easily available gems before any market limitations are a problem. A great amount of time could happily be spent cutting amethyst, citrine, and smoky quartz. These are three definite colors of one mineral, quartz, but again each of them has a number of

shade differences. As an example, citrine (yellow quartz) has definite shades indicated by names such as Rio Grande do Sul, Madiera, and Bahia. These are place names where each shade of color originated. There are also at least two faint shades that have been given no standardized name. Amethyst (purple quartz) exhibits a parallel color variety. If we look at the mineral beryl, we find a like situation; and in the case of tourmaline there are many colors and color combinations. The minerals quartz, beryl, and tourmaline could easily be worked into a fine collection without using any of the other excellent gem minerals that are available. The garnets, the feldspars, peridot, opal, topaz, and fluorite all make fine gems. Finding rough gem material of each is no great problem. If we add these to the first group, the collection may assume excellent proportions. As shall be seen later, a host of rare and unusual gem materials is available to the faceter who is diligent in his search.

The finest shades of amethyst, aquamarine (blue-green beryl), and morganite (pink beryl) are not always to be found on the market, and they do bring high prices; but the lighter shades of these make nice gems. This is generally true for most of the colored gems. Most gem and mineral dealers carry at least a small supply of faceting materials. Some houses carry large stocks, with a few specializing exclusively in faceting rough. The grades and prices of rough vary considerably from dealer to dealer, and care must be exercised when shopping. Some faceters feel that purchases should be made from dealers that specialize in facet rough, or at least carry a fairly complete stock. This is a good rule to follow, but many good buys can be made from dealers with only a small assortment. The active gem cutter will find it to his benefit not to overlook any opportunity to obtain desired materials.

Another very sound rule is to make as many purchases as possible from the dealers that are also faceters. Who would know good quality rough better than one that regularly does faceting?

Clarity Is Most Important

The first criterion of good faceting material is flawlessness. Cracks, inclusions of foreign matter, or bands of deep color are undesirable. These are sometimes collectively called flaws. In the vernacular, flaws may be any undesired inclusion; but to be correctly so named, they should be actual cracks. Regardless of how we define flaws, an undesirable inclusion in a piece of faceting rough is a serious matter.

The finding of gem rough without flaws is the constant aim of any gem cutter. Absolutely flawless material is not common, and the faceter frequently finds himself choosing from among those which are flawed. The subsequent handling and the final placement of these flaws within a gem is of prime importance. A flaw in nearly the exact center of a piece of rough would make it undesirable, unless the piece is large enough to be cut into two or more gems. Flaws in the vicinity of the surfaces can usually be removed during the grinding to general shape preparatory to faceting. This grinding is known as preforming.

Some small flaws may be left within the stone if they can be placed near the girdle. Flaws in this position are not noticeable except under very close examination.

The location of a flaw will in most cases determine the type of cut that should be attempted. If the rough is nearly circular in outline, but has a flaw about a

fourth of the way in from one side, an oval or a rectangular cut should be considered. The presence of two or more flaws in different positions, but again near the edge, might dictate a triangle or similar cut. The presence of more than two flaws usually will render the piece unusable except for a small gem. The buyer must keep in mind that he pays the same price for the flawed portion as well as the usable portion. Any material that is ground away, for whatever reason, must be added to the cost of the usable portion. A buyer must take this into consideration, or he may find himself paying a fantastic price for a small piece of rough.

Foreign matter inclusions may render a piece of gem rough unusable as they usually are of a different color and will show regardless of where they are placed within a stone. Nearly all gem material contains microscopic inclusions in the form of crystals or non-descript particles. Some types of inclusions are shown in Figures 26 to 33. It is only when these may be seen with the unaided eye that they become a real problem. It must be pointed out that even microscopic inclusions detract from the beauty of a gem, but if they are not ordinarily visible the effect is unnoticeable. Microscopic inclusions are so prevalent in all gem materials that they are used by gemologists as a method of identification, and even as an indicator of origin of the gem.

The rarity of the gem mineral will dictate to some degree whether rough with visible inclusions is good enough to cut into a gem. It seems to be an inescapable truth, that the more rare the rough the greater is the tendency for it to contain foreign matter. Under such conditions many faceters simply accept the inclusions and are very happy to have rare materials in any form.

Some Inclusions May Be Permissable

Small flaws may more or less disappear when placed near the girdle of a stone, but those lying visibly below the table will always be a blemish to the gem. If a small flaw is very near the axis of the gem it will be reflected onto all pavilion surfaces, and in turn will appear in all crown facets. Rough that will produce such a gem should be cut only when necessary.

Some gem materials are seldom found in the flawless state, and the faceter that learns to recognize a "degree of flawlessness" finds the choosing of rough a pleasure and a challenge rather than a task filled with frustrations. In direct contradiction to the above, there are a few gem materials, of which tourmaline is the most notable, that can produce exquisite gems even when flawed. This phenomenon is most apparent in gems of medium color with a refractive index in the medium to high range.

Veil-like feathers, and healed cracks consisting of bands of bubbles may be present in any gem minerals and are in most cases to be considered on a par with true flaws. In some cases, these may be turned to lie parallel to the table of the stone, and are then visible only if the gem is turned away from the usual viewing angle. These are really not continuous barriers, and light may pass through them in varying amounts. A true flaw (crack) is a different situation, and may be an almost complete barrier to light, reflecting it off in an unwanted direction. Experience will soon tell a faceter which types may be permissable, and which are not, but at best flaws are a marginal situation.

Figure 26. Veils of Bubbles in Topaz.

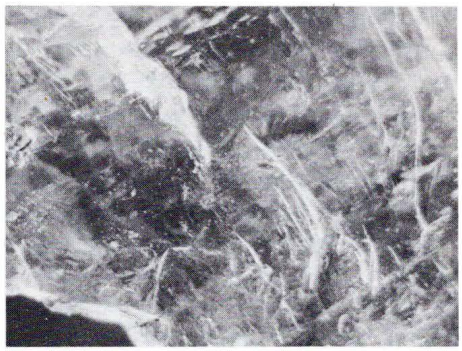

Figure 27. Cracks and Inclusions in Sphene.

Figure 28. Crystal Inclusions in Almandine Garnet.

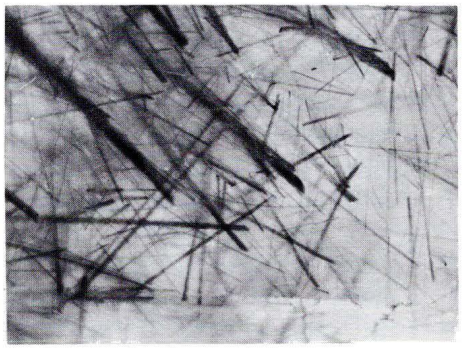

Figure 29. Tangle of Tourmaline Crystals in Quartz.

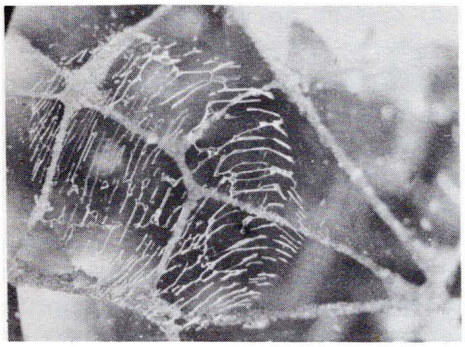

Figure 30. "Fingerprint" Inclusions in Natural Sapphire.

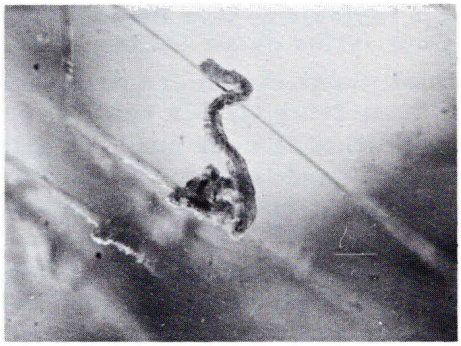

Figure 31. Worm-like Inclusions in Rutilated Quartz.

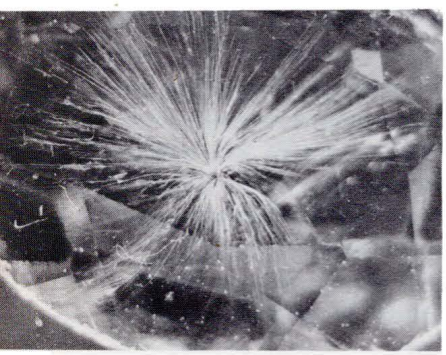

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Figure 32. "Horsetail" Inclusions in Demantoid Garnet. Inclusions of byssolite, a form of asbestos, are taken as conclusive proof that a greenish garnet is demantoid.

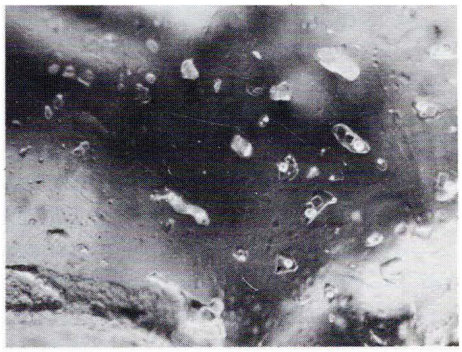

Figure 33. Three-phase Inclusions in Emerald. The cavities are filled with a liquid. Within the liquid is a gas bubble and a cubic crystal of halite.

Included Crystals Are Sometimes Assets

The presence of needle-like crystals of tourmaline, rutile, etc., may render rough unusable for many cuts, but in certain instances they can be of great value. Some faceters have searched for years for a piece of clear quartz containing a single needle of tourmaline. A gem cut from such a piece is illustrated in Figure 34. The reflection of the single needle on each of the facets of the gem illustrates the behavior of light within a faceted gem (see Figure 43, Page 61).

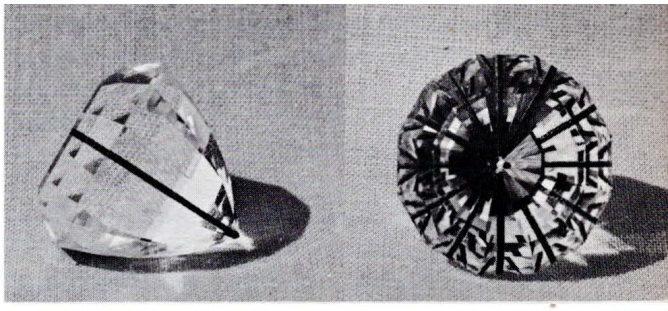

Figure 34. Two views of a Quartz Gem Containing a Single Needle of Tourmaline.

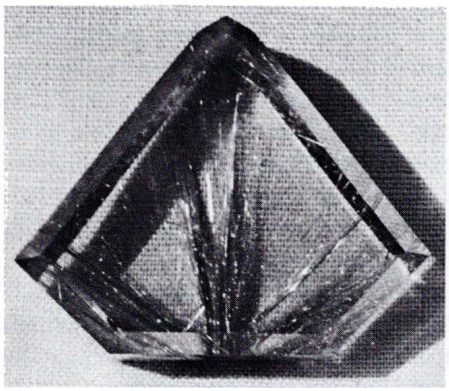

Figure 35. A Tablet of Rutilated Quartz.

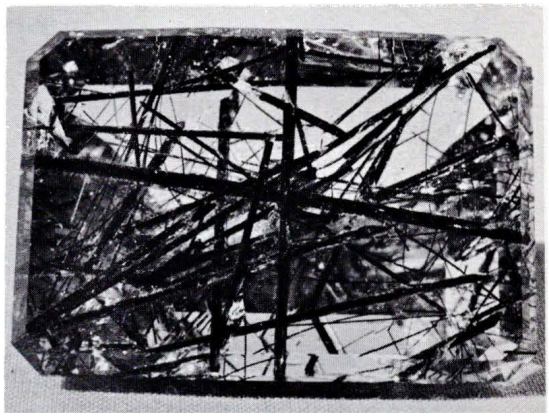

Figure 36. A Tourmalinated Quartz Gem.

A clear rutilated quartz tablet as shown in Figure 35 and a deep emerald cut tourmalinated quartz as shown in Figure 36 are not usual gems; but they are beautiful. They do not have much brilliance, but the network of crystals makes an intriguing apparently floating pattern. Many faceters are constantly on the watch for such material; it is never plentiful.

INTENSITY OF COLOR

All colored minerals show a variation in intensity of color. Many such minerals may be available in hues from a barely perceptible color to such dense coloration that a piece may appear almost opaque. The faceter must know what is possible with each hue. Most important, he must know how to recognize the hues that are usable and those that are not.

If we use amethyst as an example, we may find it on the market in large amounts in a very faint color. This is cuttable material, but it must be looked at as essentially colorless and cut accordingly. If the hue is deeper, but still faint, it could be cut using one of the cuts that intensifies color. This is further discussed in Chapter VIII in the section on step cuts, and in Chapter IX on preforming.

If the rough is of an apparently deep color, but the far side of the piece may be readily seen through it, it is a medium hue and will respond nicely to a standard step cut as shown in Chapter VIII. When the hue reaches the point that the rough must be viewed with a light behind it, the color is dark, and some type of

shallow cut must be used. If a strong light through the piece is necessary in order to determine the color, an extremely shallow stone must be cut in order to have any color in the finished state.

The examples given for color density are true for many other materials as well as amethyst.

Spots Of Color

It is usual for colored gem materials to appear with bands or spots of color. On casual examination the material may look as if it is the same density throughout. Such color variation within a piece of rough must be recognized, and handled accordingly. If there is only one band or spot of color, it may be placed in the culet of the gem as shown in Figure 37, or specifically in the case of a band of color, placed near and parallel to the girdle, as shown in Figure 74, Page 183. This will make the whole gem appear as if it is of the darker color. The handling of color and its placement is further discussed in the chapter on preforming.

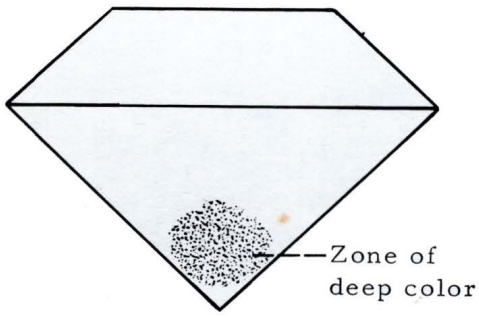

Figure 37. Placing a Color Zone in a Gem.

Opaque Materials

For many years a number of opaque minerals have been popular as faceted gems. Hematite and pyrite are the most common. The stones of pyrite are called "marcasite" by jewelers. In this case the gem transmits no light whatsoever, and is cut as a rose cut (Diagram 8) or only as a crown. This type of stone depends entirely upon reflections from the surface of the facets. In recent years, some of the translucent minerals such as jade and chrysocolla have been cut in a like manner, or as briolettes or free-forms. The latter minerals offer a small amount of transmitted color to add to the reflection, and make interesting and worthwhile gems.

CLEAVAGE AND TWINNING PLANES

Minerals with a pronounced cleavage must be handled very carefully as noted in Chapter I. Highly cleavable minerals and any visible cleavage planes must be carefully considered when choosing rough. The faceter should familiarize himself with the behavior of cleavage in general, as well as for any particular species.

Some gem minerals are frequently found as twin crystals. Twins are the result of two or more crystals uniting with or penetrating each other along certain lines according to definite physical laws. The line of attachment or penetration is known as a twinning plane, and is sometimes very important. In some minerals the twinning plane is a weak "joint", and the stone may easily split along it. This splitting may happen without warning and at any time during the cutting process. The possibility of such an event should be guarded against from the outset. If splitting is a problem, the buyer should avoid these minerals, or some pieces of these minerals.

In some cases, the twinning plane is a light barrier, and may pass light only

when it strikes at right angles. As a result, the twinning plane should be as nearly parallel to the table as possible. Any rough examined for purchase should be checked carefully for twinning planes. The presence and importance of these planes and cleavage for each species is noted in Appendix I.

SHAPE IS NEXT IN IMPORTANCE

It must be emphasized, that no matter what the shape, the faceter can usually plan on recovering not much more than one-third of the weight of the original piece. A truer picture is that, as an average, the total gem weight will seldom exceed more than 25% of the rough weight.

The only exception to this might be crystals that by their natural shape are nearly the shape of the final gem. Tourmaline when cut as rectangular stones and garnets cut as round brilliants are good examples. Cases such as this are rare in most gem species, and only the optimist can hope to obtain many of them.

Percentage Of Yield Is Small

The faceter who resigns himself at an early date to the fact that most of his rough will yield him only about 25% or less, as a final gem, will save himself frustration and heartaches. Even if the small scraps are saved and cut into gems, the yield will seldom go over 30%. Many statements are made about the faceter recovering 50% or better, but certainly the reference is to garnet, tourmaline, and a very few others. Some of these statements may be based upon the work of diamond cutters. It must be remembered that most diamonds are cut from octahedral crystals as shown in Figure 38. When the standard brilliant is cut from the octahedron, the yield is about 50%, as shown in Figure 60, Page 86. If the faceter cuts all of his gems from octahedrons, he could recover a like amount. As he seldom cuts from octahedrons, this is not the case.

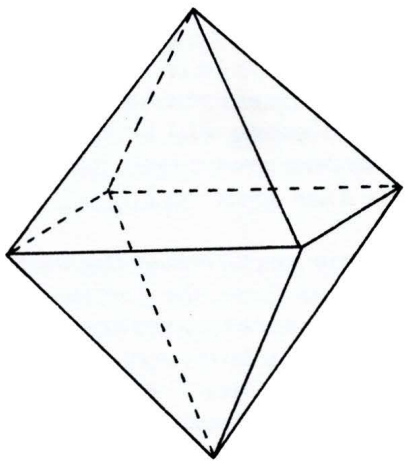

Figure 38. Projected View of the Octahedron.

Whenever the diamond cutter works with an irregular piece, the story is very different. The largest diamond ever found, The Cullinan, was such a piece and the cutters experienced a loss of 65%.* This was the case even though the scraps were cut into 96 small brilliants weighing a total of 7.5 carats. The second largest diamond, The Excelsior, lost 62%.** Diamond cutters are the finest of craftsmen, and these two stones were entrusted to the best of them. If they lost these percentages, the amateur cannot expect a better average, especially if we consider the matter of comparative techniques.

It should be obvious that rough of roundish outline should be cut into round stones; and rough of rectangular outline should be cut into rectangular stones.

* See - Gems, Webster; page 354. ** See - Gemstones, Smith; pages 241-2

These two extremes do not cover the situation, and the faceter must be alert to the possibility of a different use of an odd-shaped piece. Such an alertness will allow him to make use of a greater amount of materials and also increase his cutting experience.

The gem cutter must guard against a nicely shaped piece of rough with a deep conchoidal depression on one side. Somewhere in the process the depression must be removed, and with it will go some of the nice outline. Such rough will usually produce an entirely different shape and size from that originally planned. Under such circumstances the yield may drop far below the 25%.

PRICES OF GEM MATERIALS

The most important aspect of facet rough that most faceters must consider, is price. If the piece under consideration has all the attributes desired, but the price is such that he cannot afford it, he must look elsewhere or settle for lesser quality. Prices vary greatly from mineral to mineral and also within the varieties of a mineral. The price depends upon rarity, flawlessness, size, color, and shape; but not necessarily in that order. The degree of bearing of each of the above factors is variable for each mineral and each situation. No good rule can be set. In some of the very nice materials of extreme abundance, such as the "Rose of France" amethyst, the price may be less than ten cents per carat. The very intense color amethyst on the other hand usually brings more than $1.00 per carat. Here, rarity and color control the price; size and flawlessness have little effect. The astute faceter will find that he must learn the usual price for a given material and then act accordingly.

Contact With Dealers

It certainly is not recommended that faceters shun personal contact with dealers at their shops or at gem shows; many fine materials are to be found only under these circumstances. Nevertheless, one of the most satisfactory ways to buy is by mail on approval. Many dealers in gem rough will send their stock to a customer by mail. Most require a deposit for the first shipment, others ask only for a bank reference or the like.

Under these circumstances, the buyer can be fairly certain that the shipment contains the best the dealer has on hand. At the same time, he has the opportunity to examine the rough at leisure and without any sales pressure. The rough must sell itself. Most important of all, the buyer will very seldom find himself making a purchase without careful consideration. A dealer that readily sends out his wares to be critically examined is proud of them and he can be considered to be of the highest caliber.

Visits to shops of dealers that sell minerals exclusively are wise. Many mineral dealers have fine crystals that may yield excellent gems. Some of them may be reluctant to sell fine crystals to gem cutters, and this feeling can be understood. In the final analysis, if the act of cutting a fine crystal enhances its value, there should be little objection. At times, these same dealers receive crystal groups that have been slightly damaged in shipment, and small chips might be available for cutting. Such damaged crystals can usually be purchased for a reasonable price. The smallest dealer in the most out-of-the-way place should not be overlooked as he might have on hand one or two pieces of very excellent faceting material.

RECUTTING OF RARE GEMS

A much overlooked source of fine rare gem material is foreign cut stones. These usually are poorly cut but of good quality material, and are rejected by the jewelry manufacturer as unsuited for fine jewelry. Spinel, kornerupine, zircon, and even alexandrite can at times be obtained under these conditions. These minerals are not to be found on the market as rough pieces of any appreciable size. The reason is an economic one. Even though the rough of some of these minerals is plentiful in the country of origin (usually the orient), the native cutters would have little or no work if the rough were exported. Under the present system, the rough makes its way to the native cutter, and then to markets abroad. A parcel of native cut gems is a thing to behold; most are crudely cut, and careful sorting is in order to find the perfect gems. Those of the poorest cutting and quality are held back and disposed of into various channels. The amateur who is able to find these stones can usually obtain them at about the price that would not exceed the price of the original rough, assuming one knew the price of the rough. Many collectors have fine gems that were obtained by this method.

The recutting of one of these stones is not extremely difficult, as it can be considered as a preform. Some of the "native" facets are placed at weird angles and positions and these should be carefully noted before any recutting begins.

TRADING FOR FACET ROUGH

An active faceter sometimes finds himself being offered gem material in trade, usually from other faceters. Most amateurs accumulate more pieces of some kinds of rough then they can possibly cut. These extras can be an excellent "stock in trade". It is wise to avail oneself of this material from others if the deal is satisfactory.

Another method of obtaining gem rough, and perhaps the most obvious, is to make trips to mines, quarries, etc., in the hope of finding it. The cost of the trip can be written off as recreation, making the cost per item collected very low. Good material from such sources may also be used as trading material.

Whenever one goes to any source to look for gem material, two articles, a flashlight and a hand lens, are indispensible. The flashlight with the light pointed upward offers a fine glass table with good illumination. Rough placed here can be carefully examined for flaws. The hand lens will assist in the examination.

SYNTHETIC GEM MATERIALS

It is not intended here to ignore synthetic gems. This book can be used to guide the cutting of synthetic gems as many have identical characteristics of the natural materials. Some new synthetics have no known natural counterpart.

The synthetic forms of corundum, spinel, and rutile are commonly on the market. To date, they have not enjoyed extreme popularity, but most faceters have cut at least a few of them. They offer good characteristics that make them ideal for those interested in large stones for jewelry or to add colors to a collection. Those on the market at present do not offer any great difficulties in handling.

Ruby and sapphire, color varieties of corundum, are constantly on the market at prices of only a few cents per carat. Many rare colors of sapphire, such as padparadscha, have been duplicated, and some new ones have been added. One that is perhaps confusing is an alexandrite-colored corundum. True alexandrite is a variety of chrysoberyl, and any reference to "synthetic alexandrite" is a misnomer. To cut this material, it must be handled exactly as ruby or sapphire.

The synthetic spinels are also produced in a wide variety of colors, many of them named after similar colors in other natural materials. Such names as "synthetic peridot", "synthetic tourmaline", etc., are again misnomers. They should be referred to as "tourmaline colored synthetic spinel", etc., and are so advertised by reputable dealers. Any misnomers in no way detract from the beauty of the gems.

A sort of "Cinderella" of the synthetics is Titania, the trade name for synthetic rutile. This material is higher in price than the two above, but the great ability of this material to break light into the spectral colors makes it quite desirable.

Other synthetics have been made, usually as part of industrial research. Strontium titanate (fabulite) is not available at present. Quartz, fluorite, scheelite, garnet, and others have been obtained by some faceters, but only through special channels.

Synthetic emeralds have been known for some time, but cuttable crystals have not been offered to the amateur to date. Nearly opaque crystals appear on the market irregularly, and these may be cut for curiosities. Some manufacturers have used two pieces of colorless spinel to make a triplet with a fused green glass as a cement holding them at the girdle. These have been called synthetic emerald by some, but this is most certainly another misnomer and to be avoided. The older name of Soudé Emerald* is certainly to be preferred.

* See - Gems, Webster; page 343

Chapter VI

Optical Properties

THE OPTICAL PROPERTIES of gem minerals are of the greatest importance in cutting a gemstone. When the faceter understands what happens when light enters a faceted stone, where it goes or can go, and what may happen when the light emerges he will be well on the way to producing fine gems.

REFRACTIVE INDEX

The optical property of prime importance is refractive index, sometimes written simply as R.I. In the simplest terms, refractive index is the speed of light within a transparent substance, compared with the speed of light in air. A number is used to express refractive index and the base for air is 1.0. This number is the reciprocal of the comparative speeds. A gem with a refractive index of 2.0 forces the light to travel at exactly one-half of its speed in air. The better types of zircon have a refractive index of over 1.90. It can be assumed that light within zircon travels slightly over one-half of the speed in air. The faceter should understand that a ray of light is slowed to some degree when it moves from air into any substance that is transparent and has a greater density than air. The greater the number, the greater is the refractive index for the material. This will suffice for most purposes. Light within any given substance will travel at the new slower rate the entire time it is passing through the substance, but regains its former speed upon emerging into air.

Minerals With More Than One Refractive Index

In Chapter I it was shown that all minerals are classed according to six crystal systems. These systems are based in part on the length of various crystallographic axes. It has been found that when a mineral has two or more axes of different lengths, light travels at a different rate of speed for each axial direction.

In a mineral forming in the isometric system (Figure 3, Page 10) all axes are equal in length, and light will travel at exactly the same speed in all directions. Thus the mineral has only one refractive index. In the tetragonal and hexagonal systems (Figure 4, Page 10) there are axes of two different lengths, resulting in these minerals having two refractive indices. The remaining three crystal systems, orthorhombic, monoclinic, and triclinic (Figure 5, Page 11) have axes of three different lengths, and have three different refractive indices. Even though some minerals may have more than one refractive index, these indices may not be entirely constant as light speeds may be higher or lower than normal depending upon the amount and type of impurities that may be present. The number of indices, however, never changes as a result of impurities.

We have three distinct groups of minerals, depending upon the crystal system to which they belong. The first group includes minerals crystallizing in the isometric system, and all amorphous substances. Even though amorphous minerals have no crystal system, light may travel in all directions at the same speed. These minerals are called isotropic, and the single refractive index is usually stated as a single number such as 1.50 or symbolized by n, indicating a normal or constant situation (thus n=1.50).

The remaining crystal systems are called anisotropic, and comprise the second and third group. The second group includes the tetragonal and hexagonal systems. These are known as the uniaxial minerals. Uniaxial gems have two refractive indices, and are usually expressed as o=1.50 and e=1.54. The difference between the two indices indicates the degree of double refraction. The o symbol indicates the ordinary ray which never varies in velocity. The symbol e denotes the ray known as extraordinary, which varies in velocity depending upon which direction it travels within the crystal.

The third group, the remaining part of the anisotropic minerals known as the biaxial minerals, has three refractive indices which are usually stated as, a=1.50, b=1.54, and c=1.58. The symbols a, b, and c indicate directions of light travel within the mineral.

The refractive indices of the anisotropic minerals are stated as an average by many authors. This arithmetical mean will suffice for faceters as there is usually little difference between the extremes, and it would be difficult to determine the exact axis in most cases. All refractive indices listed here for any anisotropic gem mineral will be this average, unless there is an important reason for doing otherwise.

How Refraction Takes Place

If we use glass as an example and allow a ray of light to strike one surface at 90°, we have the situation shown in Figure 39A. The line at 90° is known as normal. In this case, the light is entering at normal, and is traveling in a perfectly straight line through the glass. To the observer it appears as if

nothing has happened to the light ray, but it has been slowed during its passage. To prove this we must have light enter at other than normal. A light ray striking a surface is referred to as incident at a certain angle. In Figure 39B, a ray of light is incident to the glass at 20° from normal. As the ray enters the glass, it is bent slightly toward normal, and travels at this new angle to the opposite surface. When it emerges from the glass, it is bent away from normal. The ray leaving the glass is known as the emergent ray. We can now state; any incident (entering) light ray striking a transparent material at other than normal is upon entering refracted (bent) toward normal. When the ray emerges it is refracted an identical amount away from normal.

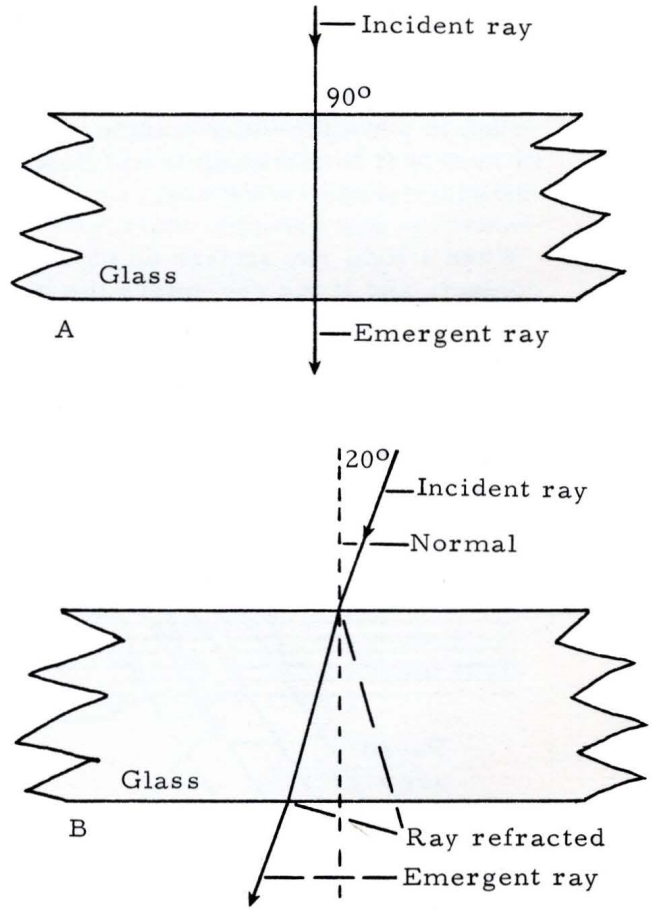

Figure 39. Light Traveling Through a Sheet of Glass.

The amount of refraction depends upon two factors, (1) the refractive index of the material, and (2) the angle of the ray away from normal at the time of entry, known as the angle of incidence. In materials with a high refractive index, refraction at the time of entry is greater than those of lower R.I. As the angle of incidence moves away from normal, the refraction toward normal increases, but not at the same rate, and in no case can the angle of incidence or the refractive index be increased to bring the ray within the substance to normal. The only time that a ray may travel at normal within a substance is when it enters at normal as in Figure 39A.

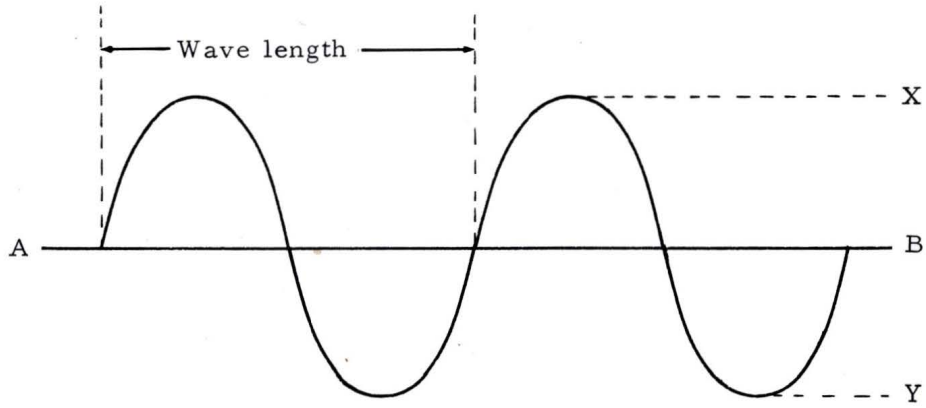

Figure 40. A Simplified Diagram of a Light Wave.

How Light Rays Refract

Refraction of light is due to the fact that a light ray actually has breadth. * Figure 40 shows a portion of a light ray. The illustration is much simplified in order to show the wave feature. The ray is shown vibrating in only one plane. In reality it is vibrating in all directions around the line AB. The width XY is the width of the entire ray.

When a light ray strikes an object at other than normal, one side is first in contact; and if the ray enters the object, this portion is slowed while the balance is still moving at the regular rate. This can be nicely illustrated as shown in Figure 41. Let us imagine a squad of men marching upon a paved area and

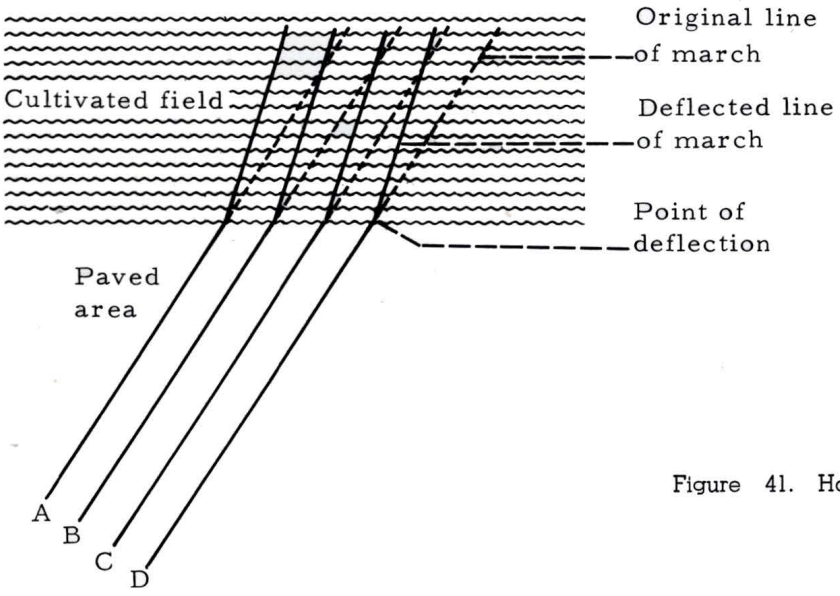

Figure 41. How Refraction Takes Place.

approaching a plowed field at an oblique angle. Individual A reaches the field first, and upon entering, cannot walk as fast as he did on the pavement. During the interval of time between when A enters the field and before B enters, B, C, and D are still moving at the original speed. At the same intervals of time C and finally D enter the field, but D has not been slowed during the period of time that the others were being slowed, and each was slowed for a different period of time. This has caused the squad to make a turn to the left.

If the field were only moderately cultivated, the difference in walking speed would be slight and the amount of turn would be slight. If the field were deeply plowed and very rough, the slowing and subsequent turn would be greater. If we could draw an analogy, we might say that a deeply plowed and very rough field would have a greater "deflective index" than a lightly cultivated field. If the squad entered the field at a 90° angle, there would be no deflection at the time of entry and all men would simultaneously travel slower.

* See - A Textbook of Mineralogy, Dana; page 224, sections 314-15

REFLECTION OF LIGHT RAYS

After a light ray enters a transparent medium, and is traveling in a new line, the line is straight until it strikes another surface. Upon striking another surface the ray may either emerge, or it may reflect and remain within the material. It may reflect a number of times, but it can be safely assumed that it will finally emerge, and at that time will take on its final refraction. The reflection of light within a transparent material is a very important behavior and is further discussed in Chapter VII regarding facet angles.

Regardless of the condition of the surface which a ray of light enters, there is usually some reflection. This reflection increases as the angle of incidence moves away from normal. As the faceter has little or no control of this outside reflection, it is ignored in most deliberations, and only the assumed percentage that enters is taken under consideration. The following illustrations of light behavior in faceted gems are shown on an idealized gem cross section as in Figure 42.

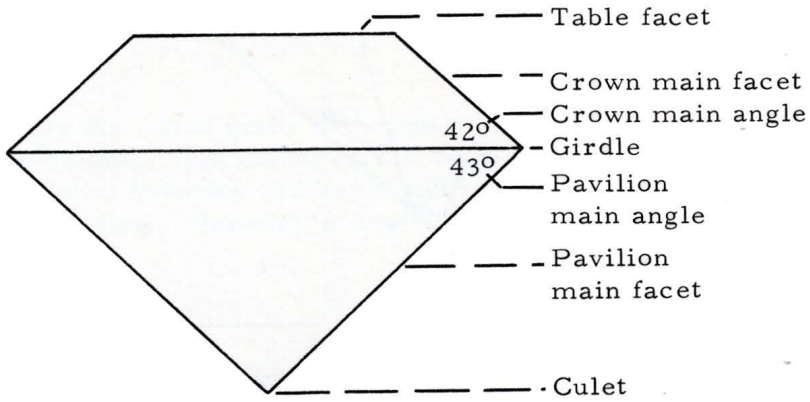

Figure 42.
Basic Drawing Used for following Illustrations.

Total Reflection

Figure 43 shows a ray striking the table at normal. The ray travels within the stone to the pavilion, reflects twice, and emerges with refraction, through the crown facets. This condition is known as total reflection, and is the ultimate aim in the design of faceted gems. It should be noted that the ray strikes the

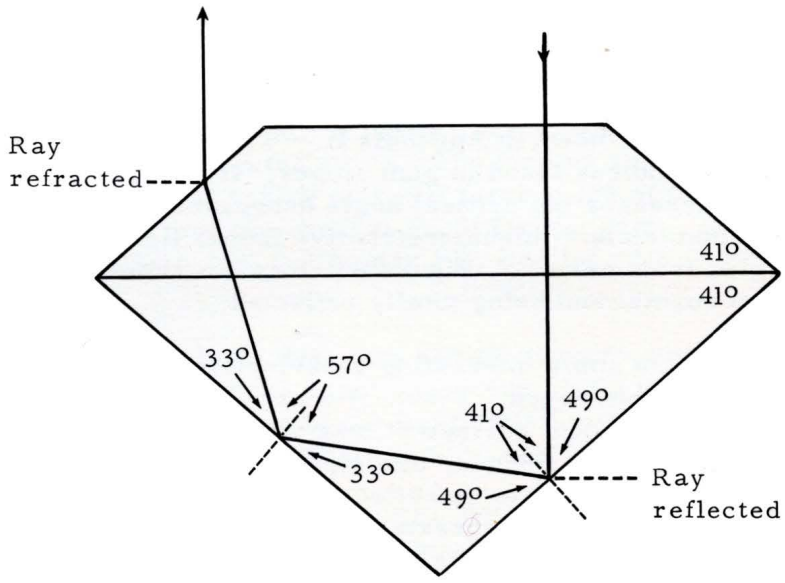

Figure 43.
Total Reflection in a Gem.

first pavilion facet at 41° and is reflected at the same angle. The same is true for the second pavilion facet at an angle of 57°. This equality of angle of reflection is always true. Both angles are measured to either side of normal. It should also be noted that in this case, a quartz gem, the first angle of incidence is 41° from normal.

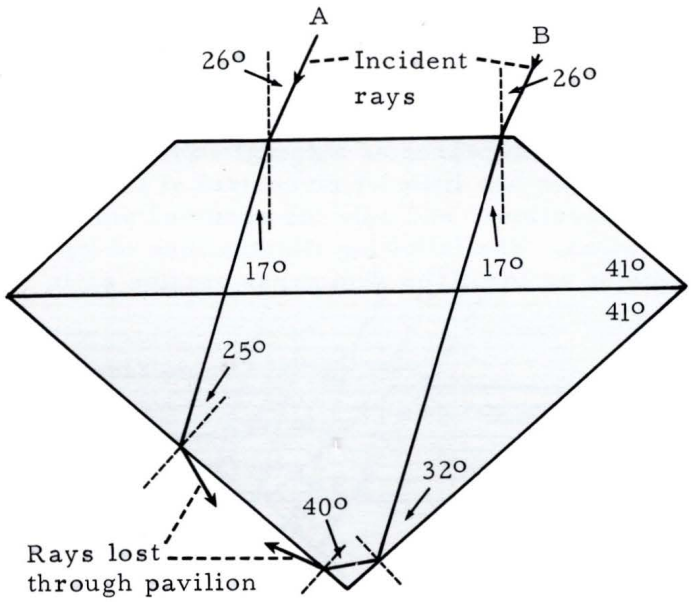

Figure 44.
Maximum Inclination of a Light Ray.

A second illustration, Figure 44, shows the same gem with a ray entering the table at 26° from normal. The ray is refracted upon entry, and emerges from the gem upon striking the second pavilion surface. In this case, the second angle of incidence is 40°. If we investigate, we find that (for quartz) all rays within a gem, incident to any surface at less than 40.2° from normal, would emerge from the gem at the point of impact. Also, all rays that are incident at an angle greater than 40.2° from normal will be reflected within the gem.

Critical Angle

The above angle (for quartz) is known as the critical angle of total reflection, or simply, critical angle. It is a function of refractive index derived through the formula shown in Appendix II. Table 8 gives the critical angles for the refractive indices found in gem stones. It will be noted from the table that as the R.I. increases the critical angle decreases. As a result we find that within the gem materials of higher refractive index, light may reflect at much smaller angles from normal. Figure 55, Page 76 shows light entering zircon at 30° from normal and being totally reflected.

There are some interesting behaviorisms of reflection and refraction that should be mentioned. First, if a ray of light is to enter a gem surface, it must be incident to that surface at less than the critical angle for the material, or it will reflect off. Second, this same feature holds true (in reverse) within the gem. If the ray is to be reflected and held within the gem, it must now be incident to the surface at greater than the critical angle, or it will emerge. If we refer to Figure 43 it will be noted that if the gem is quartz (with a critical angle

TABLE 8

REFRACTIVE INDICES AND CRITICAL ANGLES

Mineral	Refractive Index	Critical Angle in Degrees	Mineral	Refractive Index	Critical Angle in Degrees
Fluorite	1.44	44	Demantoid	1.88	32
Opal	1.46	43	Sphene	1.94	31
Calcite	1.49	42	Zincite	2.00	30
Feldspar	1.52	41	Cassiterite	2.06	29
Quartz	1.55	40		2.13	28
Beryl	1.59	39		2.20	27
Topaz	1.62	38	Wulfenite	2.28	26
Peridot	1.66	37	Sphalerite	2.37	25
Zoisite	1.70	36	Diamond	2.45	24
Chrysoberyl	1.74	35	Crocoite	2.56	23
Benitoite	1.78	34	Rutile	2.67	22
Andradite	1.83	33			

The refractive indices for the listed gems are median figures. To find the critical angle of a gem not listed, find the RI on the table and use the corresponding angle. Those indices between the listed figures may be assumed to have intermediate critical angles. One-half a degree of critical angle is as close as is needed.

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of 40.2°), each of the reflections from the pavilion facets are incident above the critical angle. Third, if a ray is to emerge it must be incident to the surface it strikes, at an angle less than the critical angle. If it is not incident at less than the critical angle, it will reflect within the gem as above. Referring back to Figure 43, we find the light ray emerging through the crown at an angle of incidence below the critical angle.

If we are to enjoy the benefits of the phenomenon of refraction (and double refraction and dispersion discussed below), gems must be designed and displayed so that light rays, either entering or leaving the gem, are at an angle of incidence less than the critical angle of the material.

The term critical angle means exactly that. It is the critical point below which no light ray will be reflected within the stone. The faceter should be alert to the fact that gems must not be cut at angles that will force much of the light to strike a pavilion surface at less than the critical angle for the gem. This feature is further explored and illustrated in Chapter VII, dealing with determining facet angles.

The above examples and those used later deal with angles of entry with an incidence fairly close to normal. Under the usual conditions, light strikes a gem at nearly all conceivable angles. Some of the light striking any facet is incident at an angle greater than the critical angle, and is lost by reflection.

Most rays of light that could enter, in all probability will be lost out of the gem because of the wide angles of incidence. In all later discussions, we shall

be concerned with light rays that are reasonably under control. It is imperative that the faceter be positive that the facet angles used are within certain limits in order to affect as much control as possible. If the angle of the pavilion facets is very near the critical angle, most, if not all, of the rays entering the table of the gem will be lost out of the pavilion. A faceted stone of this type reflects little or no light in the central portion, and it is possible to see through the stone. This is referred to as a "fish eye", and is shown in Figure 45. This

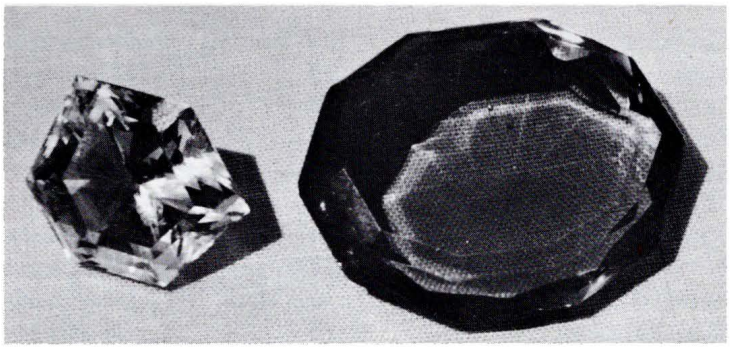

Figure 45.
Comparison of a Correctly Cut Gem and a "Fisheye."

is to be avoided as such a gem will have brilliance only near the girdle. The fish eye effect tends to appear at angles a number of degrees away from the critical angle and increases noticeably as the critical angle is approached. The critical angle is not one to be approximated; stay as far away from it as possible.

SPLITTING OF LIGHT RAYS

Many gem materials exhibit the property of splitting a ray of light and refracting two rays in divergent directions. Upon emergence there are two rays instead of the one that entered the material. This property is known as birefringence, or more commonly as double refraction. Figure 46 is an example.

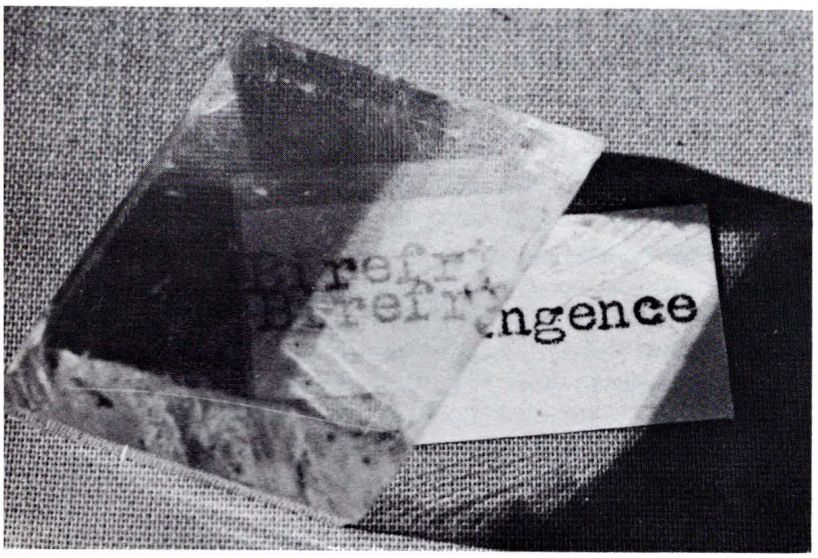

Figure 46.
Double Refraction as shown by Calcite.

The most immediate effect of birefringence is that a gem appears to have double facets on the pavilion, as in Figure 47. Such gems are preferred as this facet doubling is an apparent increase in brilliance.

The two rays of light emerging from a birefringent gem are found to be a

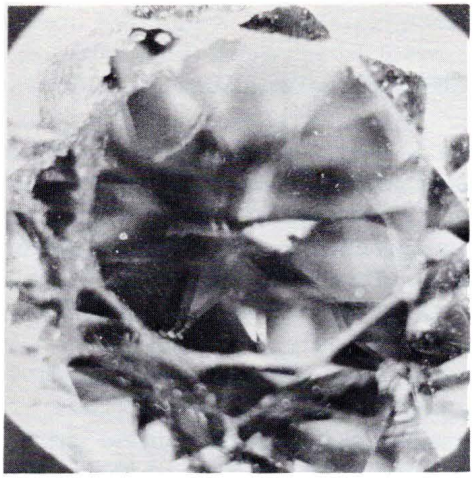

Figure 47. Double refraction in a Zircon Gem.

Photograph by
Charles J. Parsons, G.G., F.G.A.
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certain number of degrees apart, and each has a different refractive index. The numerical difference between these two indices is taken as the amount of birefringence.

Birefringence is more common among the gems of medium to high R.I., and the amount is potentially greater as the refractive index increases. Doubly refractive gems of low R.I. may exhibit birefringence, but under such conditions, it may be hardly noticeable. Table 9, Page 66 lists the R.I. and birefringence for the better known gems.

Dispersion

Some gems have the ability to break white light into the colors of the spectrum. The phenomenon is not limited to any group of minerals. Brilliance and dispersion are not related. Brilliance is the result of the ability of a gem to totally reflect light rays that enter it. A high refractive index enhances this property. Dispersion is the result of the ability of the gem to differentially refract the various colors of the spectrum.

As in birefringence, dispersion is measured by the two extremes of refraction, but in this case it is the difference between the refraction of the red ray and that of the violet ray. Each of the colors of the spectrum has a different wave length and when passing through certain substances, each ray may be refracted a different amount. The red rays are refracted the least, while the violet rays are refracted the greatest amount.

The pavilion of a gem is cut at certain angles in order to reflect most of the rays that strike it. If the pavilion facets have returned the light rays to the crown, the crown facets may now disperse the light. Gems such as zircon or sphene have a great potential to do this, while a fluorite gem has almost no potential.

No matter how strong the dispersive qualities of the gem may be, the crown facets must be inclined correctly to show it. Rays leaving a gem at right angles to the surface normally will show no dispersion, but light emerging at an angle close to the critical angle will show a great amount of dispersion.

Any gem that exhibits dispersion is usually more desirable because any brilliance that it may exhibit as a result of a high refractive index, now also shows an added play of color. This play of the spectral colors is usually referred to as "fire". Dispersion is easily demonstrated by the use of a prism of glass as in Figure 48. Table 9 (page 66) shows the relative amount of dispersion of the more common gems.

Pleochroism

Another optical property of gems of interest to the faceter is pleochroism. This is the ability of the gem to completely absorb all but one color of the

TABLE 9

OPTICAL PROPERTIES FOR IMPORTANT GEMS

Gem	R.I.	Birefringence	Dispersion	Pleochroic Colors
Andalusite	1.64	weak	none	red, green, and orange
Apatite	1.64	weak	low	Burma stones only
Axinite	1.68	medium	none	colorless to brown-violet
Benitoite	1.76	strong	high	colorless and blue
Beryl	1.58	weak	low	emerald is dichroic
Braziliante	1.58	weak	none	none
Chrysoberyl	1.75	weak	low	light to dark colors
Corundum	1.76	weak	medium	light to dark colors
Danburite*	1.63	weak	low	none
Feldspar	1.52	medium	low	light to medium colors
Fluorite	1.43	none	low	none (isometric)
Garnet group	1.75	none	high	none (isometric)
Iolite	1.53	weak	low	blue, yellow, and white
Opal	1.44	none	none	none (amorphous)
Peridot	1.65	strong	medium	dark to light colors
Phenacite*	1.66	medium	low	none
Quartz	1.55	weak	low	usually none
Rutile	2.60	strong	high	in dark colors only
Sphalerite	2.34	none	high	none (isometric)
Sphene	1.91	strong	high	light to dark colors
Spinel	1.72	none	medium	none (isometric)
Spodumene	1.67	medium	low	strong, light to dark
Topaz	1.62	weak	low	in dark colors only
Tourmaline	1.63	medium	low	strong, light to dark
Zircon	1.91	strong	high	dark to light colors

From this table it is quite easy to determine the fine gems. As a general rule, a R. I. of 1.62 and above can be considered good, 1.75 and above as excellent. The presence of birefringence and/or dispersion increases the value of the gem. Any pleochrosim may enhance the gem by adding a second color. It is interesting that danburite* and phenacite* show below average indications, but as they are usually exceptionally clear, the gems are very excellent by virtue of the refractive index alone.

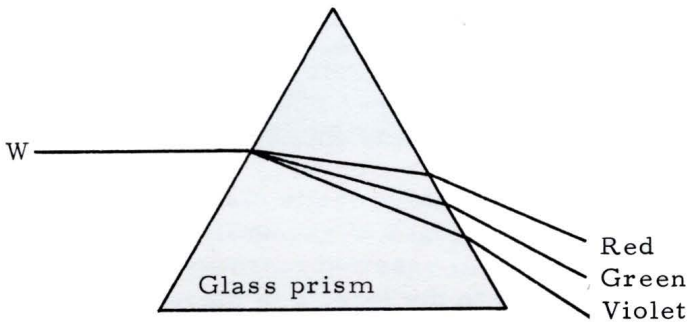


Figure 48.
Light Entering an Equilateral Prism.

spectrum through a certain crystal direction or directions. The property is tied directly with the crystal form of the mineral and is possible only in the anisotropic group. Table 9 lists the pleochroic features of the common gems.

Uniaxial crystals may exhibit pleochroism through two directions, and the term used is dichroic, or showing dichroism. There may be two different colors, or two hues of the same color. The biaxial minerals may show this phenomenon through three directions with the term trichroic or showing trichroism being used. The colors may be different in each direction, or may be three shades of the same color.

Catering to the properties of pleochroism can help to produce fine gems of clear crisp colors, and conversely, ignoring it can devaluate a material by producing an unwanted color, or a gem of no character. In tourmaline (as shown in Figure 49) the color across the crystal may be a fine clear green, whereas

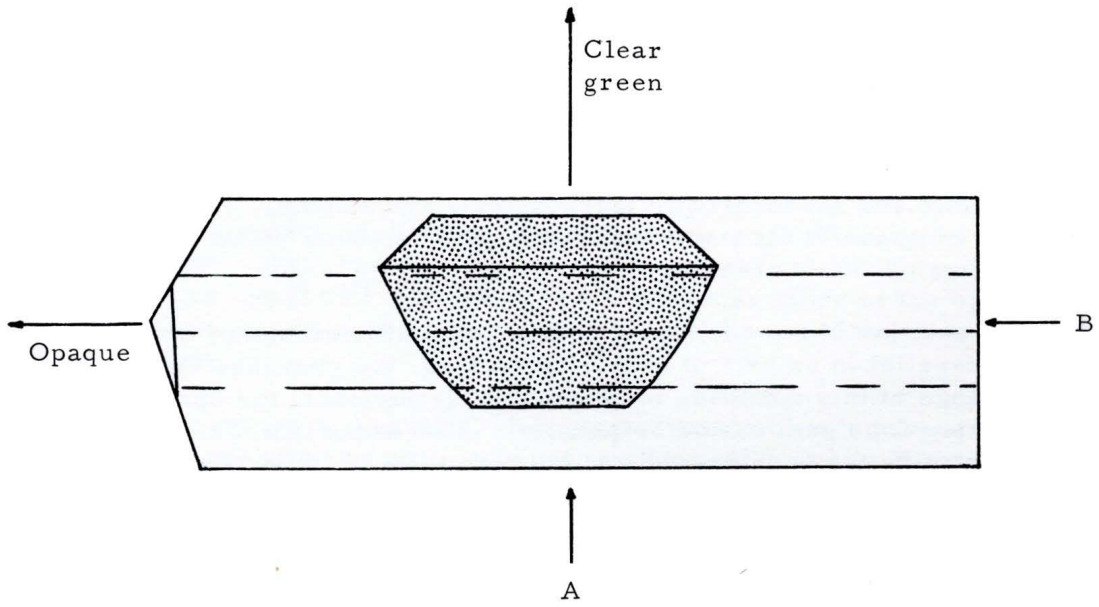


Figure 49. Orientation of α Green Tourmaline Gem.

the color through the length of the crystal may be muddy or opaque. The effect is strong in the greens, reds, and blues, but not as strong in pink and other light shades. The deeper colors of tourmaline are always cut as shown in the illustration whether as step or brilliant cuts. The lighter shades may have the gem oriented in the other direction, but this is not always the best practice. Kunzite, the lilac variety of spodumene, is handled differently. The table of the gem is placed at near right angles to the long axis of the crystal to take advantage of the fine color.

Iolite, a gem variety of cordierite, exhibits strong trichroism. Through one axis the color is a deep pleasing blue; through another it is an unpleasant yellow; and through the third direction the material is almost colorless. Iolite has no great hardness nor high refractive index, and its one attribute as a gem is its deep sapphire blue. To produce a fine iolite gem it must be carefully oriented to show the blue color. The first move that one might make could determine whether or not the finished gem would be of any value. Optical properties are further discussed in Chapter VII in regard to the orientation of rough preparatory to preforming.

THE OPTIC AXIS

Orientation of a piece of rough into the correct position for the best finished gem is covered in later chapters, but light paths within a gem material are of some concern. The isotropic minerals will allow light to travel in all directions without any changes or impediments. As a result, these minerals can be oriented in any way with little concern about how the light will travel.

The anisotropic minerals are somewhat different. Light travels at different speeds through different axes of the crystal. With these gems we are concerned with the optic axis. Briefly, the optic axis is the direction of travel which has only single refraction. This direction compares very favorably with the isotropic situation. Uniaxial minerals have one optic axis and biaxial minerals have two optic axes.

There is very little argument concerning the placement of the optic axis in line with the vertical axis of the gem. Under this condition the gem will pass the light from table to culet with little or no distortion. Birefringence in some anisotropic minerals, in a direction other than the optic axis, may be so strong that the gem may appear fuzzy. Fuzziness is ordinarily confined to the minerals with a birefringence of .10 and higher. Those of most importance are rutile, calcite and rhodochrosite (carbonates), and sphene. The species descriptions in Appendix I list several other rare facetable minerals that have a birefringence of .10 or greater.

If the orientation of the vertical axis of a gem cut from one of these minerals is nearly parallel to an axis of double refraction, the gem may appear fuzzy. The avoidance of this condition is desirable. If possible, the optic axis and the vertical axis of the gem should be parallel. Two important facts remain which tend to minimize the problem. First, the property is important in only a few of the gem minerals; and second, the determining of the optic axis is difficult to do without instruments. It is possible to disregard the optic axes except in rutile, the carbonates, sphene, and a few others. Natural rutile is usually so dark in color that the fuzziness is not apparent. Synthetic rutile is best purchased as preforms from a reliable dealer, or boules may be carefully oriented according to directions obtainable from the manufacturer.

Crystals of the uniaxial minerals (tetragonal and hexagonal) may be oriented by the crystal form. The optic axis in these minerals is parallel to the c (vertical) axis of the crystal. The group of minerals known as the carbonates contain the greatest number of those that need to be oriented to the optic axis. These can usually be oriented by the use of the crystal.

When the piece of rough is not a crystal, or is one of the biaxial minerals (orthorhombic, monoclinic, or triclinic) the location of the optic axis is difficult without a polariscope. If a polariscope is available, a piece of rough, either uniaxial or biaxial, is placed between the polarizing plates and rotated in a horizontal plane. Under ordinary circumstances, the piece will appear alternately dark and light two times per revolution. If the piece is turned in all directions while being rotated horizontally, a point will finally be found where the piece will be dark, or nearly so, for an entire horizontal revolution. When this position of maximum darkness is found, a small mark is placed upon the uppermost central portion of the piece. It is then turned completely over, and the process repeated. The optic axis now lies between the two marks.

THE CUMULATIVE EFFECTS OF OPTICAL PROPERTIES

The optical properties of any gem when considered together have a profound effect upon the brilliance of the gem. The effect upon the viewer is dependent upon the following characteristics in the following descending order: (1) clarity of the material, (2) refractive index, (3) dispersion, (4) birefringence, and (5) the density of color. The low character of any of the first three lowers the value of the gem. A gem of poor clarity is usually of little value. A gem high in the first four, and low in color density is usually an excellent gem. An increase in color density may enhance the gem, but great depth of color will devalue it.

The above five features are very relative, and may not carry the same weight in all gems, but their relative position in the descending scale cannot be ignored. In Table 9 a reference was made to phenacite and danburite being gems of high brilliance even though of medium refractive index, birefringence, and dispersion. The two minerals are a seeming paradox, but the high clarity of these materials is in part responsible for the brilliance. As a comparison we might cite fluorite. Most facetable pieces of fluorite are exceedingly clear, but because of the very low refractive index, the gem has no real brilliance. The high clarity gives it the look of being empty or hollow.

It now is obvious that the definition of brilliance on page 65 must be looked at a little differently. Brilliance is the result of the cumulative effects of the optical properties. If one or more of the optical properties is low, or missing, the overall possible brilliance of the gem suffers in a relative amount.

It must be further noted, however, that gems capable of returning a great amount of brilliance must be correctly cut in order to show it. Diamond cutters have taken a material capable of returning high brilliance (there are others with greater brilliance) and by careful study and constant improvement have made it into a most desired gem.

Chapter VII

Angles For Faceting

IF THE THESIS of Chapter VI is to be considered true, the optical properties of gem minerals are not to be ignored, and should be given careful consideration when a gem is in the planning stage. Few faceters deliberately ignore the optical properties, but it is surprising how much variation exists in the comparative thinking about them. Most gem cutters accept the stone proportions, cutting angles, and facet sizes as set forth in the book of their choice. Some faceters may vary angles to some degree, depending upon an idea or past experience, while others freely change the angles to suit the shape of the rough material on hand. Those that make no changes are following the line of least resistance, which is usually a sound practice. This is especially true in view of the fact that most amateurs are lacking in time and want to get as many gems cut as possible.

A QUEST FOR BETTER GEMS

From time to time a few individuals who are not satisfied with their results take an idea and develop it. It is good that we have individuals that are striving for new ideas, for if nothing else, some of their methods and at least portions of their ideas are valuable. It is doubtful, however, if any new idea, except a very radical one, could make more than a five percent difference in the brilliance of a gem; and this could not easily be determined without the aid of instruments.

Most of the light that enters a gem, even with the best of planning, never gets

back to the viewer; and all the drawings on paper, as well as mathematical formulas, will not make it do so. Most gems have a wide degree of latitude as far as light behavior is concerned, and small changes will make little difference.

A most interesting part of the story is that quartz and its gem varieties do not exhibit much latitude, but surprisingly, quartz is the gem most used to show new ideas and techniques. Quartz is probably one of the poorest gems with which to experiment as shown later in this chapter. Undoubtedly the poor latitude of quartz is responsible for the investigations. This coupled with its ready availability is a constant prod to the faceter seeking the best possible results.

Diamond Cutters Agree On Methods

If there is disagreement about angles for cutting the common gems, the exact opposite is true among diamond cutters. There is virtually no difference of opinion as to gem proportions or correct inclination of facets. It has been found that an angle of slightly less than 41 degrees for the main (culet) facets of the pavilion is ideal. It has further been found that any change to a smaller angle tends to deaden the gem.* Diamond has a critical angle of just under 25 degrees (24° 26') thus there is a spread of about sixteen degrees between these two angles. Conversely, any change toward steeper angles results in a gem that is too tall and is difficult to mount into jewelry. Also, some light is lost by increasing pavilion angles.

It must be remembered that diamond cutters have cut millions of gems. Their methods and results have been pooled and studied and any conclusions must be sound. The diamond industry has had large amounts of money at its disposal, and the problems have been pursued in all directions. The amateur would be wise to use any of their information that may be transferred to other gems. For instance, if it is true that a diamond begins to deaden in brilliance as soon as the culet angle drops appreciably below 40 degrees, the same is true for gems of lower refractive indices.

SOME BASIC PREMISES

Before we enter into discussion as to how to find facet angles, facet sizes, and gemstone proportions, a few basic premises should be set forth. Even though there appears to be differences in ideas and methods between the cutters of gems other than diamonds, there is little difference of opinion as to the following.

Accuracy of Cutting Angles (1)

It is difficult with most faceting machines, to place a facet with an accuracy of less than one-half degree. Some machines will no doubt come to this figure, most will not. Such inequity is due to a number of factors. In the case of a few machines, they may be inaccurate, or have been made so by use. In other cases, the protractor may be very accurate, but difficult to read. With the best machine in the hands of an operator with poor eyesight, the results will be erratic. It is recommended that the faceter not approach, closer than one degree, the critical angle of any material.

Return of Light by Gems (2)

If a faceted gem is to accept and return light as shown in Figure 43, Page 61,

* See - Gems and Gem Materials, Kraus and Slawson; page 103

then-it is important that the crown of the stone be designed to gather as much light as possible and have a good ballance of surfaces for acceptance and return.

A gem with an exceedingly large table would accept a large amount of light, but would have insufficient crown facet surfaces to refract this light when it emerges. In the opposite case, a gem with a very small table would have insufficient light gathering power. The experience of diamond cutters has shown that a table of about 50% of stone width is best under most conditions.* In practice, the table size can be varied to as low as 40% or as high as 60% without any undesirable effects. Some gems are deliberately cut with the table much larger than 50% of the width of the stone. This has the effect of making the stone appear larger. It is in a sense fraudulent, and it is of no advantage to the amateur.

This 50% ratio of table to girdle width should be carefully examined. If a faceted stone were 10mm in diameter, the table would be 5mm in diameter. It would have an area of approximately 20 sq. mm., with the crown facets having a horizontal area of about 60 sq. mm., or about three times larger. This might seem to be an inequity, but it must be borne in mind that the crown facets gather light as well as return and refract it. It is true that the table returns as well as gathers light, but any light that returns through it is refracted a very small amount. The table contributes little to the brilliance of a gem by returning light. Its function is to gather light, while the function of the crown facets is primarily to return and refract light. The secondary function of the crown facets is to gather a lesser amount than the table. The portion of the crown that carries a dual function should be larger.

Height of Crown (3)

The second premise leads us to the third. If there is a constant relationship of table and girdle width, the crown height must have a reasonably constant relationship to the depth of the pavilion. Long experience has shown that a ratio of about two times pavilion depth to one of crown height is best. This is also the experience of diamond cutters.** This ratio and its variations is discussed later. It stands to reason that if the pavilion must be cut to exacting requirements, and that the crown has certain ratios constantly in evidence, then the relative size of the crown and pavilion must be fairly constant.

Viewing Angle of Gems (4)

Gems are most brilliant when the table is nearly at right angles to the source of light; and further, the viewer should be as near as possible to the same plane followed by these light rays. The development of part of the reasons for this premise is handled later in this chapter.

Light striking a table at normal would enter the gem without any reflection. Also, as the angle of incidence is moved away from normal, reflection would increase until it would be possible that no rays would enter the table.

* See - Gems and Gem Materials, Kraus and Slawson; page 103

** See - The World of Jewel Stones, Weinstein; page 333

INCLINATION OF THE PAVILION FACETS

As was shown earlier, the pavilion facets are inclined at certain angles in order to achieve total reflection. It has also been shown that the light rays must strike pavilion facets above certain angles in order to be reflected within the gem.

Accomplishing total reflection for the greater number of light rays is difficult. This is not a reason to accept defeat, but instead should be a challenge to attempt to do the best possible under the circumstances. It is presumed that this is the impetus that triggers much of the investigation noted in the early paragraphs of this chapter. In order to begin to solve this problem, it is necessary to determine the maximum and minimum efficient cutting angles, as well as those that are optimum.

To illustrate this, we shall use quartz as it is a low refractive index gem. Any conclusions can be utilized to better advantage for materials of higher refractive indices. Figure 50 shows a quartz gem with pavilion and crown angles of 46°. Both angles are measured from the girdle. Rays of light are striking

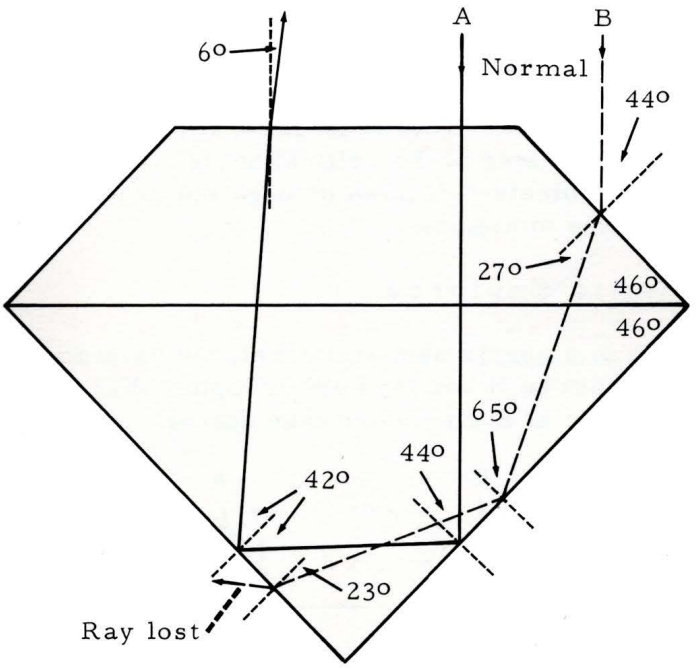


Figure. 50
Quartz Gem with Facets Inclined at 46° from the Girdle.

the stone at normal to the table. The ray A entering the table is incident to the first pavilion facet at 44° from normal and incident to the second pavilion facet at 42°, and emerges through the table at nearly normal. The incidence angle for the second pavilion facet is less than two degrees greater than the critical angle. It shows that a pavilion of slightly over 46° would not reflect rays normal to the table. The ray B entering the crown is refracted upon entry and is lost through the second pavilion facet. It may be concluded that crown and pavilion angles of less than 46° would be advantageous.

Figure 51 shows a quartz gem with crown and pavilion angles of 41°, again with

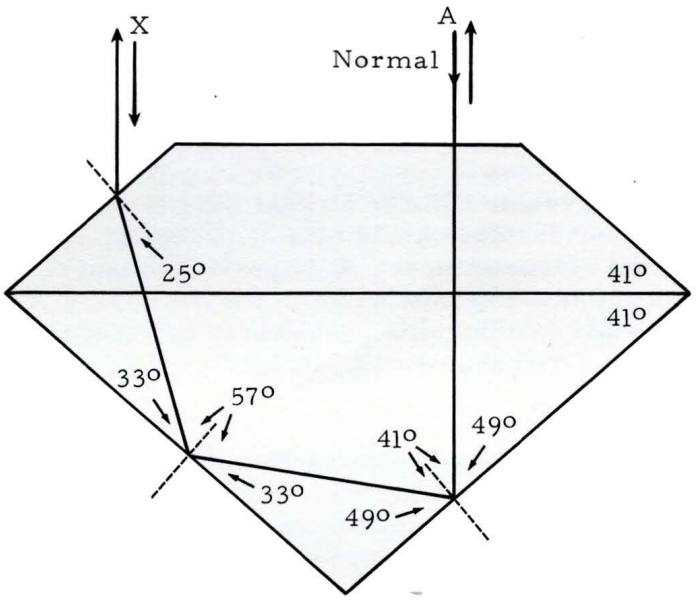


Figure 51.
Quartz Gem with Facets Inclined at 41° from the Girdle.

the rays striking the gem at normal to the table. The ray entering the table strikes the first pavilion facet at 41° from normal. This is less than one degree above the critical angle. If we reverse the ray and have it enter the crown facets, it will follow the same path in reverse. This is an ideal situation except for the fact that the first reflection is too close to the critical angle. Regardless of the fact that the emergent ray is nicely refracted through the crown facets, the 41° pavilion angle is the absolute minimum.

Maximum And Minimum Limits Explored

For a ray of light entering the table of a quartz gem at normal, we have now determined that the pavilion facets cannot be lower than 41° or higher than 46°. Let us now look at rays entering the table at angles other than normal. Figure

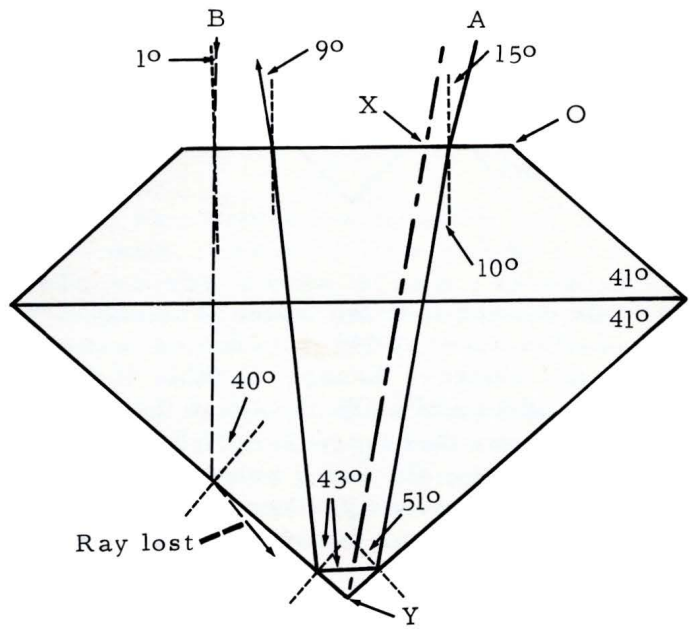


Figure 52.
Quartz Gem Receiving Rays at other than Normal.

52 shows a gem with a 41° pavilion and rays of light incident at 15° and 1° from normal.

Ray A, entering the right side of the table, is refracted to 10° from normal, is reflected, and emerges through the table. This ray could be lowered to 25° from normal and still be totally reflected, but would still emerge through the table. Ray B at 1° from normal enters the left side of the table and is lost through the first pavilion facet.

If we return to ray A, we see that a serious deficiency is developing. By the increase of the angle of incidence, we have decreased the area of the table that may receive and reflect the ray as shown. The portion of the table XO is all that can do this. When we change the incidence to 25° the area XO drops to less than 10% of the table area. It may sound excellent that we can totally reflect a ray that enters at 25° from normal, but when we find that we are using only 10% of the table surface we really have gained nothing.

Now we must find an angle for the pavilion facets that will do the most under the greatest number of conditions. As we are confined between the angles of 41° and 46°, it would seem logical to try a near midpoint of 43 degrees. This is illustrated in Figure 53. The ray A entering at 15° from normal is totally

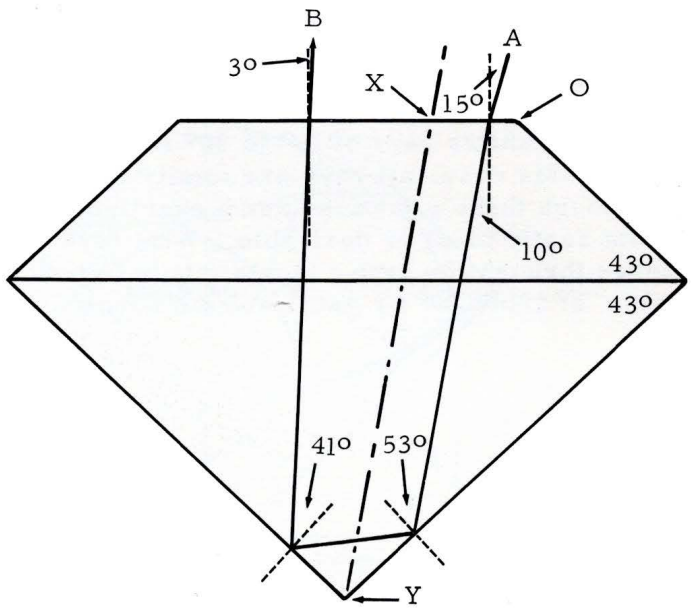


Figure 53.
Quartz Gem with Facets Inclined at 43°.

reflected and emerges through the table. If we reverse the ray and call it ray B, it now may enter at 3° from normal and be totally reflected. The ray at 15° from normal is the limit of inclination. Ray B will totally reflect through the whole table.

It is true that this situation is far from ideal, but under the limitations imposed by quartz, it appears to be the best we can do. By using a 43° pavilion angle we can totally reflect all rays striking the table at up to 3° from normal, and all rays to either side of the center of the table at up to 15° from normal. This may be accomplished through at least 25% of the table area involved.

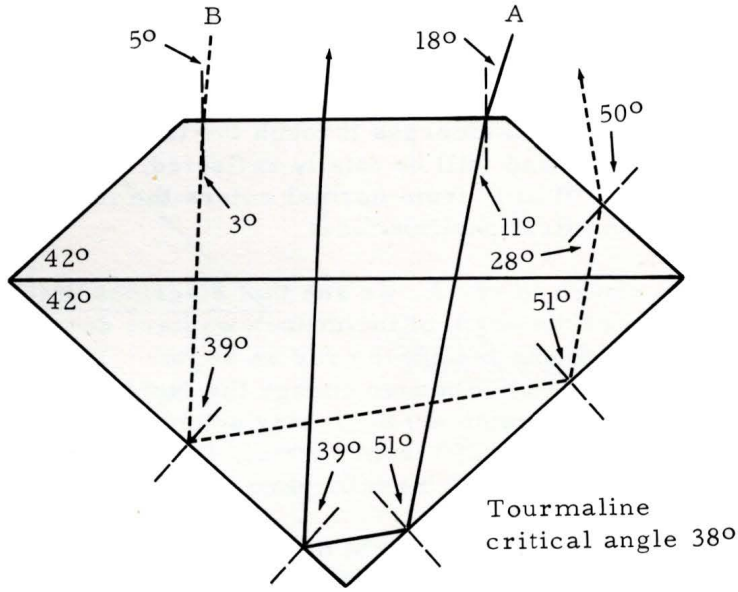


Figure 54.
Light Rays Entering a Tourmaline Gem.

Let us look at pavilion angles in relation to gems of higher refractive indices and smaller critical angles. For tourmaline, with a refractive index of 1.62, and a critical angle of 38°, a pavilion angle of 42° appears to be satisfactory as shown in Figure 54. As the refractive index increases, rays incident at greater angles away from normal are refracted toward normal within the gem and are more easily totally reflected.

Figure 55 shows rays of 15° to 30° from normal striking the table of a zircon gem. In this case, all rays are totally reflected. It must be emphasized that even though these situations seem excellent, they are extreme for each case and are not really ideal or desirable. With rays closer to normal, more light will emerge through the crown facets. It is important to point out that rays striking a table at about 20° or greater from normal are greatly reflected and few will

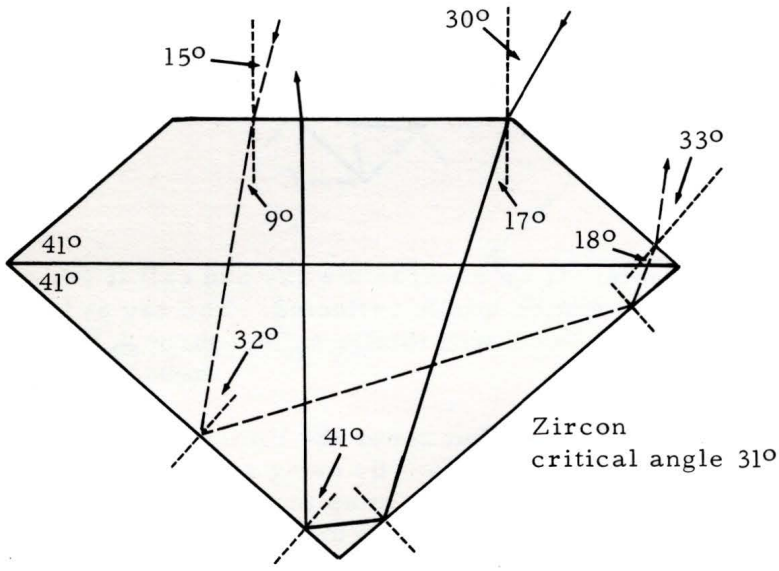


Figure 55.
Light Rays Entering a Zircon Gem.

enter the gem. None will enter any gem if they are incident at greater than the critical angle. In the case of zircon, however, the adamantine luster from these reflections will enhance the brilliance of those that do enter. Zircon is one of few that will show this phenomenon.

The Culet And Crown Angles

In the foregoing discussions, it has been pointed out that there are optimum angles at which the pavilion and crown must be inclined. There is no type of common faceted gem that has only one facet angle for either pavilion or crown. All popular gems have a pavilion that has at least two types of facets with a corresponding number of angles of inclination. The crown of most gems has at least three types of facets, each with its own angle of inclination. Thus, only one set of facets will carry these optimum angles.

We have shown that a certain angle for the pavilion is optimum. Since all facet cuts have the smallest angle at the culet, this optimum angle should be the angle that closes the culet. In all further discussions this angle is referred to as the culet angle. A like angle on the crown is referred to as the crown angle.

Light Gathering By The Crown Facets

In the foregoing illustrations it has been shown that for crown angles greater than 40°, it is difficult to totally reflect rays striking the crown facets at angles near normal to the table. It must be borne in mind that there are facets on the crown at angles other than 40° as shown in Figure 56.

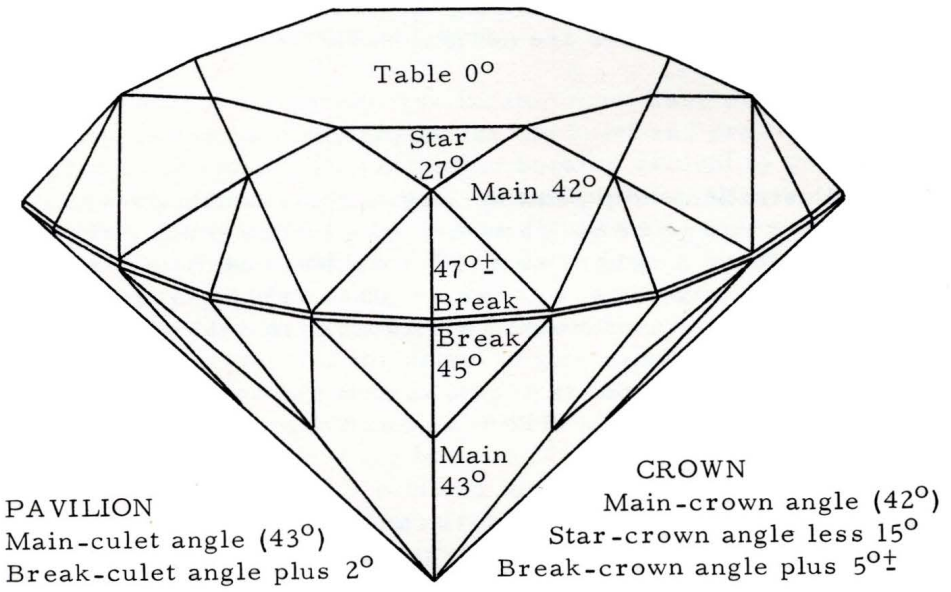


Figure 56. Facet Angles for a Quartz Brilliant.

After the illustrations and discussion above, it should be evident that a gem that gathers light only at normal would not always be brilliant throughout. Under most lighting conditions, there are light rays in all planes, and here the crown facets come into play.

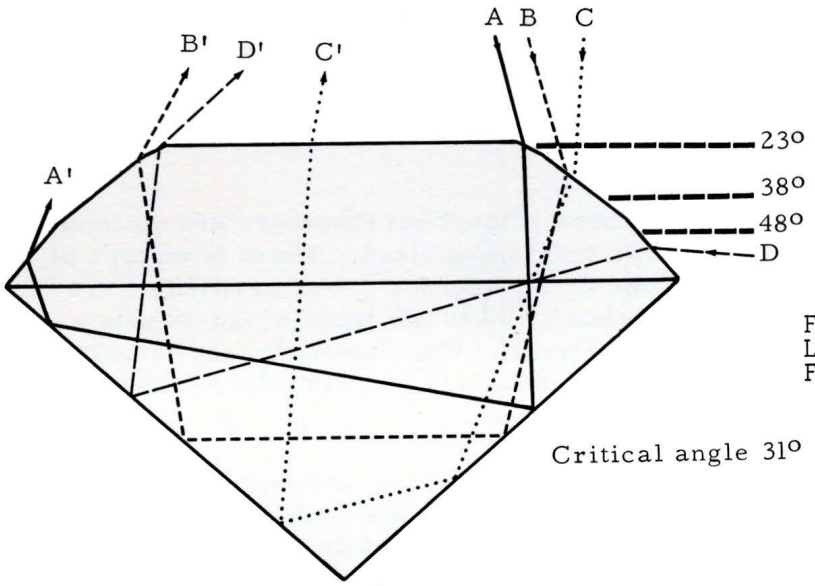


Figure 57.
Light Gathering by the Crown Facets.

Figure 57 shows light entering both sides of the crown. This band of coverage added to what has been shown in other illustrations indicates the great potential of the brilliant cut. Figures 50 to 56 showed only the most ideal rays because of space limitations within the drawings, and Figure 57 also has this limitation. Most facets will accept rays a few degrees on each side of those shown and still totally reflect them. This also points out that the crown angles of any gem may be changed to some extent without dire consequences. Small changes will have minor effects, but normally these are not noticeable. Great changes will, nevertheless, be disastrous.

Some Conclusions

The foregoing illustrations help point the way to some conclusions.

(1). For all transparent gems, regardless of refractive index, the pavilion angles should not be cut near the critical angle. If facets are cut near the critical angle, light rays only slightly away from normal to the table will be lost through the pavilion.

(2). In order to return the greatest number of light rays, the main facets of the pavilion should be inclined at about 42°.

(3). Even though rays more than a few degrees from normal can enter the table and be totally reflected in the gems of the higher refractive indices; only those entering near normal will return through the crown and be refracted.

The third conclusion points back to the fourth premise given earlier in this chapter. If rays enter at or near normal, they should be returned likewise. For them to be seen, the viewer must be nearly in the same plane.

It must be borne in mind that we cannot control all light rays and make them enter gems only as in the illustrations shown here. It cannot be too strongly stressed that under most conditions light is entering a gem from all directions. In addition to this, we have the viewer looking at the gem from many positions.

These two situations give gems their ever-changing and unending beauty. At the same time, these highly variable and uncontrollable conditions make it virtually impossible to come close to designing the ideal gem shape.

As the individual characteristics for each gem differ in varying amounts from other gems, it would mean that we would need to design a separate gem shape for each gem material; indeed, it might mean the designing of a separate shape for each variety of gem. This would only further complicate the already complex problem, and it is doubtful if any gains of real consequence would be made. The best that could be done in all cases would be to strike a compromise between extremes. This is essentially what has been done for many years, and is exactly what is being done today. Every idea advanced for improving gem cuts is fraught with the very indefinite term "if". Regardless, each new idea teaches us something that may be applied to some part of the gem cutting process.

The authors know of an instance where one of our modern computers failed to calculate the optimum angles for faceted gems. A prospectus citing the desired behavior of light upon emergence, the reasonable conditions of lighting that a gem might be subjected to, and optical properties of the common gems were placed in the hands of the operator. When programmed for the computer, these conditions were found to be so variable, both from the standpoint of light directions and gem characteristics, that any applications would not produce consistent results. The project was abandoned.

This points out that the foregoing discussions are very inadequate in presenting the complete picture of light behavior in gems. The only attempt made is to account for the more predictable rays, with the others of lesser importance being ignored. Even though these are ignored, they still make up part of the overall picture and add brilliance to a gem.

In spite of this unstable situation, the faceter must have something for a guideline. There are nearly as many angles for the culet and crown as there are individuals proposing them. This situation became evident to the authors early in their faceting experience, and almost immediately an attempt was made to try to remedy it. After some study, it was decided that the methods of the diamond cutter were the best to follow. There have been a number of references to diamond cutters made previously. After the handling of the diamond was studied, it was necessary to transfer the information to the gems of the amateur, and the following graph of important angles is the result. The angles offered for the culet and crown are, in most cases, an average or median of most of those from other sources. The authors and their students have used them for many years, and they have been satisfactory from many standpoints.

The pavilion and crown angles offered on Figure 58 have been referred to previously in connection with various discussions. They differ in varying degrees from those offered by other authors, but definitely are not to be considered as refuting them. The attempt here is to try to bring about some semblance of order and continuity into a chaotic situation. The angles are not offered as the last word, but as a guideline to assist those that are perplexed with the situation. The authors are very cognizant of the fact that there will be some disagreement with the angles offered. Those that disagree will have very valid arguments, and can be backed by previous statements herein regarding the huge amount of latitude in all conditions surrounding faceting materials and the displaying of gems.

GRAPH OF IMPORTANT ANGLES

The graph in Figure 58 plots the important angles for faceted gems. Line A is the critical angle curve. The points along this broken line are plotted for the minerals named along the margin which shows refractive index. The dot-dash line B is the minimum recommended for the culet angle in any transparent material. This is the safety factor offered in premise number 1 earlier in this chapter. Common sense dictates that a lesser angle not be used for the culet of a transparent gem. Line C, the short dash line, plots the optimum main crown facet angles. The solid line D plots the culet angles for the pavilion. This line is the most important line on the graph, and any variation of it for any species will have noticeable effects on the gem.

Lines C and D are straight, but in the case of line D, it is curved on the upper end in order to not intersect the critical angle curve in the vicinity of 42°. If the dotted portion of the line were followed, all gems with a refractive index below 1.52 would automatically become fisheyes.

Line D, for the culet angle, was plotted by connecting 40° and 40.3° with a straight line. The 40° angle is suggested for titania by the manufacturers, and the 40.3° angle is that used for diamond. When this line was extended it intersected quartz at 42°, and ran very close to most of the usual angles used for the other gem materials. The curve was introduced to intersect line A at 44°.

The fact that the culet angle line has been deliberately moved to the right in the vicinity of 42 degrees may seem to be tampering with a principle. Many independent studies have been made to try to determine the optimum angles for a brilliant cut stone. These studies have not been in complete agreement in their results, but in general it has been found that optimum culet angles run from about 39° for diamond to 40.6° for quartz.* This quartz angle is almost exactly the critical angle. Figure 58 tries to follow this spread of degrees, but it was imperative that the culet angle line be moved to the right in order to accomodate quartz and others with low refractive indices.

These same studies have shown that the crown angles should ideally be higher than the graph shows. In the case of quartz an angle of 44.5° was found to be best. Tourmaline showed an angle of 53.1° as optimum. These angles resulted in stones with the crown too large in proportion to the pavilion. They have a top-heavy appearance, and do not wear well in jewelry. Much lower angles have been used for many years and those offered here are considered the better choice, at least in the eyes of the authors. This again points out the fact that the crown angles may be lowered if necessary.

The crown angle line on the graph has been plotted in the following manner. The angle used by diamond cutters is usually 32.3°, and the angle recommended by the manufacturers of synthetic rutile is 30°. When these two points are plotted on the graph and the line extended, it intersects quartz at 42°. This is the crown angle that has been used for many years, and has been found to be best under most conditions. The crown angle for all other gem minerals has been adjusted to match this line.

* See - Gems and Gem Materials, Kraus and Slawson; page 104

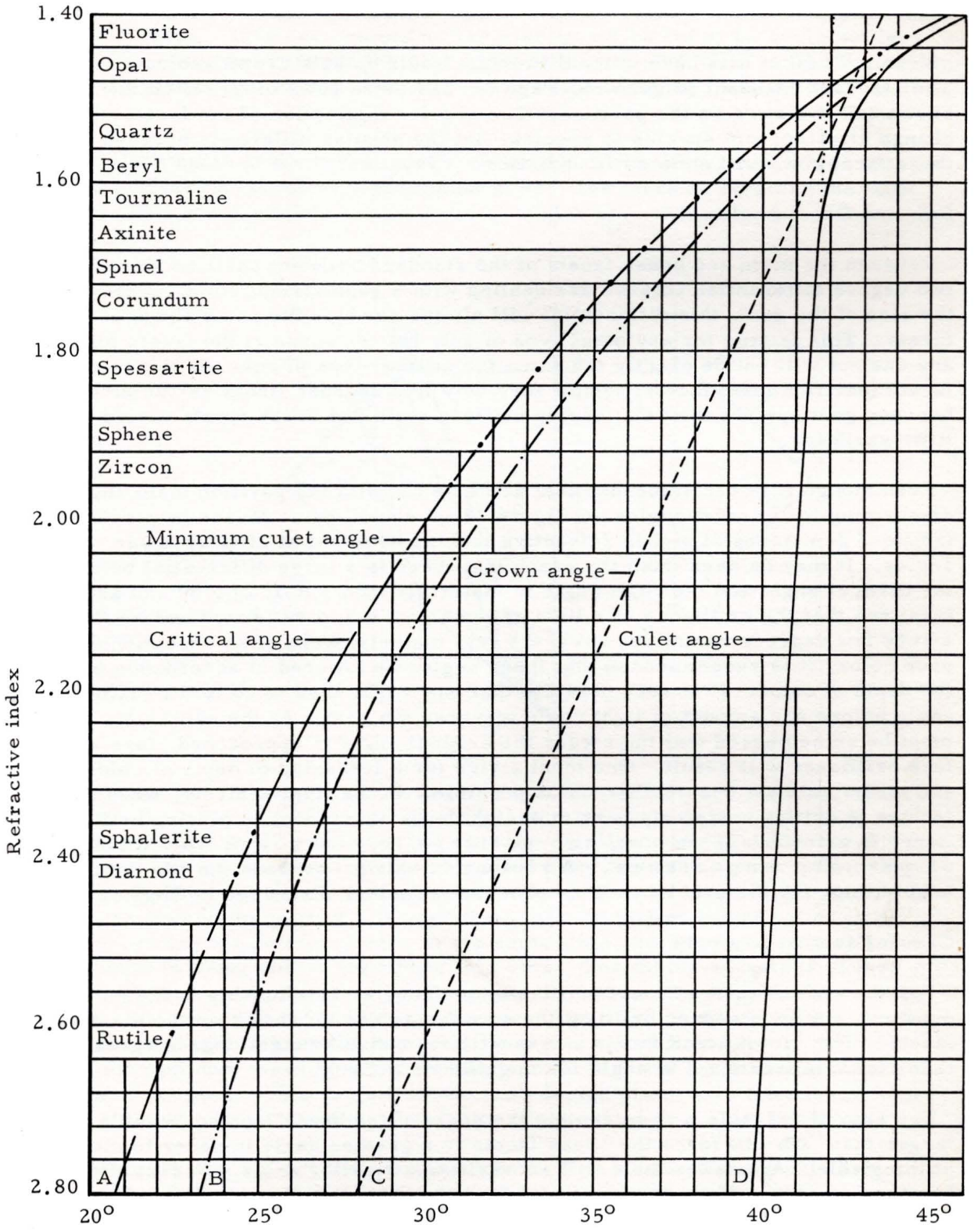


Figure 58. Graph of Critical, Crown, and Culet Angles.

When the refractive index of a material is known, this graph may be used to find the critical angle, line A; the crown angle, line C; and the culet angle, line D. The line B is the lowest angle that may be used without danger of producing a "fisheye" gem.

The Function Of Other Than Main Facets

Nearly all facet cuts have more than main facets on both crown and pavilion. The standard brilliant (Figure 56, Page 77) has three rows of facets on the crown and two rows on the pavilion. The angular inclination of the facets will change slightly from species to species, but the angular difference between these facet rows will show little variation.

Pavilion Facet Angles

Between the main and break facets of the standard brilliant pavilion there is a two degree differential. As we are dealing with a geometrical solid, whatever the size of the gem, this differential will always produce the same shape of facets. This is true for any other type of cut, but the shape of the facets for any one cut will not be exactly the same for another type of cut. As the culet facets (pavilion main facets) should vary only five degrees (from 45° to 40°) between gem species the relationship between main and break facets should have little variation.

Even though it is recommended that gems be cut with the pavilion main angles conforming to the culet angles on Figure 58, it should by no means be a catastrophe if gemstones of higher refractive indices were cut at slightly lower angles. It may be seen from the graph that there is a large differential between the critical angle and the culet angle in materials with a R.I. of 1.80 and above. It is true that the brilliance of a light colored gem would suffer with more than a very few degrees variation, but if the gem material were of an exceptionally deep color, it is recommended that these angles be lowered in accordance with the depth of color. It is very possible that one might need to go to the critical angle before any amount of light could traverse the gem. At the same time it must be remembered that the closer the critical angle is approached, less and less brilliance will result. One must strive for a lessening of depth of color, and still retain as much brilliance as possible. In the final analysis, when a faceter is cutting extremely dark material, he is automatically placing brilliance in a secondary position, and getting light through the gem is of primary importance. A reasonable balance between the two is the best outlook for the problem. This process is further discussed in Chapter VIII.

Crown Facet Angles

For the crown facets of most brilliants, the angular relationship is not entirely constant. In the standard brilliant the star facets are 15° less than the main facets. The crown break facets are usually from five to eight degrees greater than the main facets. The angle for the table facet is 0°.

The size of the table will determine the angle of the break facets. A table larger than 50% will force the break facets to a greater angle in order to close at the girdle. A smaller table will necessitate a smaller angle. In case the faceter finds himself short of material to make the usual shaped crown, he may have to reduce all angles. Errors of judgment in the original planning of the gem, or an accident during cutting, may necessitate this course. Regardless of whether or not the crown is normal, the break facet angles must be adjusted to fit the situation at hand. More explicit directions for this closure of the crown, as well as the cutting of the table, are given in Chapter X.

The variation of crown angles between gem species is great. This is pointed

out in the graph in Figure 58. The angle of the star facets might be a problem in some cases. It is recommended that star facets be cut at an angle not less than 20°. The best rule for the placement of the star facets is to find the angle that will make them extend about one-third of the distance from the table to the girdle.

If we look again at the three facet rows on the crown (Figure 56, Page 77), we find the breaks at about 50°, the mains at 42°, the stars at 27°, and the table at 0°. This gives a fairly even spread of angles across the crown. Figure 59

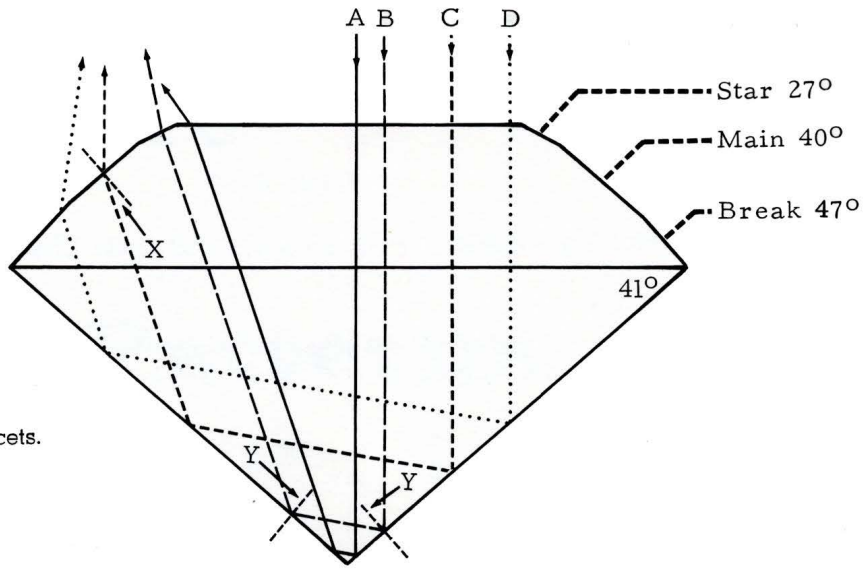


Figure 59.
Refraction by the Crown Facets.

shows rays within the gem reflecting up from the pavilion and striking these facets. Four rays, ABCD, are at normal to the right side of the table of a zircon gem with a 41° pavilion. All rays are totally reflected. The ray A emerges through the table, and is refracted away from the viewer. The rays BCD strike the star facet, main facet, and break facet respectively; each emerges toward the viewer. It is obvious that the viewer might not be in a position to see all emerging rays at the same time, but he needs only slight movement to bring one of the others into view, thus taking advantage of the gem's characteristic "sparkle". The angle X must be less than the critical angle, otherwise the ray would not emerge. The angle Y should be greater than the critical angle to keep the ray from emerging. Ray C which emerges at normal, the optimum viewing angle, is doing so through the largest facet on the crown of the gem. This is exactly what the design of the gem intends. If other rays strike the left side of the table, the whole crown would be illuminated.

Those rays that reflect from the pavilion in the vicinity of the girdle are close to parallel to the pavilion facets and need much refraction to bring them near to normal to the table. Those striking the star facets are close to normal to the table and need less refraction to be brought to normal. There are many intermediate rays that strike these two types of facets as well as the main facets. A study of Figure 59 will show that it is difficult to cover all possibilities, but the standard brilliant does nicely within the limits of its design. The multi-facet brilliants do a much better job in that they have a proportionately greater number of facets, but in relation to girdle widths, they are deep stones. The

basis of choice between these types of cuts is covered in Chapter VIII.

Height To Width Relationships

If the angles as shown in the graph are adhered to, the standard brilliant will show a height to width relationship of .7 to 1 in gems with refractive indices between 1.50 and 1.75. Those of lower refractive indices will approach 1 to 1, and those of higher indices will be about .6 to 1. To illustrate this ratio, a quartz gem following these angles and having a girdle width of 10mm will be 7mm from table to culet. These relationships are shown in Table 10. The obtaining of these proportions, as well as those of the step cuts, are covered in the chapter on preforming.

TABLE 10

WIDTH VS. HEIGHT FOR STANDARD BRILLIANT GEMS

Gem	R.I.	Main Facet Angles (degrees) Pavilion	Crown	Height % of Width	Crown Depth % of Pavilion
Fluorite	1.43	45	44	74	48
Quartz	1.55	43	42	71	47
Beryl	1.58	42	42	68	49
Tourmaline	1.63	42	41	66	47
Corundum	1.76	42	40	65	45
Zircon	1.95	41	38	62	44
Sphalerite	2.35	40	33	58	38
Diamond	2.42	40	32	57	36
Rutile	2.67	40	30	56	33

If the above culet and crown angles are used for all materials with comparable refractive indices, it can be readily seen that only the low refractive index materials have a depth of about three-fourths of the width, and a crown about half the depth of the pavilion. These ratios become smaller as the refractive index rises. Gems with a refractive index over 2.0 are about half as deep as wide, and the crown is about one-third the depth of the pavilion.

Chapter VIII

Faceted Stone Patterns

MANY PATTERNS ARE used for faceted gems. These are commonly known as facet cuts. Only a few are significantly different types; the others being variations. Basically there are only two types, the step cut and the brilliant cut. The brilliant cuts are often referred to as the round brilliants. Each of these two basic cuts is modified to produce many interesting patterns; or the two types may be combined into the mixed cuts.

THE ROUND BRILLIANT CUTS

The round brilliant is exactly what the name implies, a round stone that shows brilliance. It is characterized generally by being composed of triangular and kite-shaped facets. The brilliant cut was somewhat late in appearing as it calls for quite precise machine settings. This was not possible until the advent of the jamb-peg machine. The forerunner of the round brilliant was the table cut shown in Figure 60.

Early diamond cutters produced the table cut (E) by simply truncating the upper portion of an octahedral crystal to make a table facet. This cutting operation led to the name. Usually a very small culet facet was placed on the lower point, but it is not shown in the illustration. The natural crystal faces were polished without any changes in size or shape. The very small waste of this method is shown by the dotted lines in figures A and C. The brilliance of this cut is very low, and the greater size is no help in a comparison to a brilliant cut of the same girdle dimensions. The later use of the octahedron for the

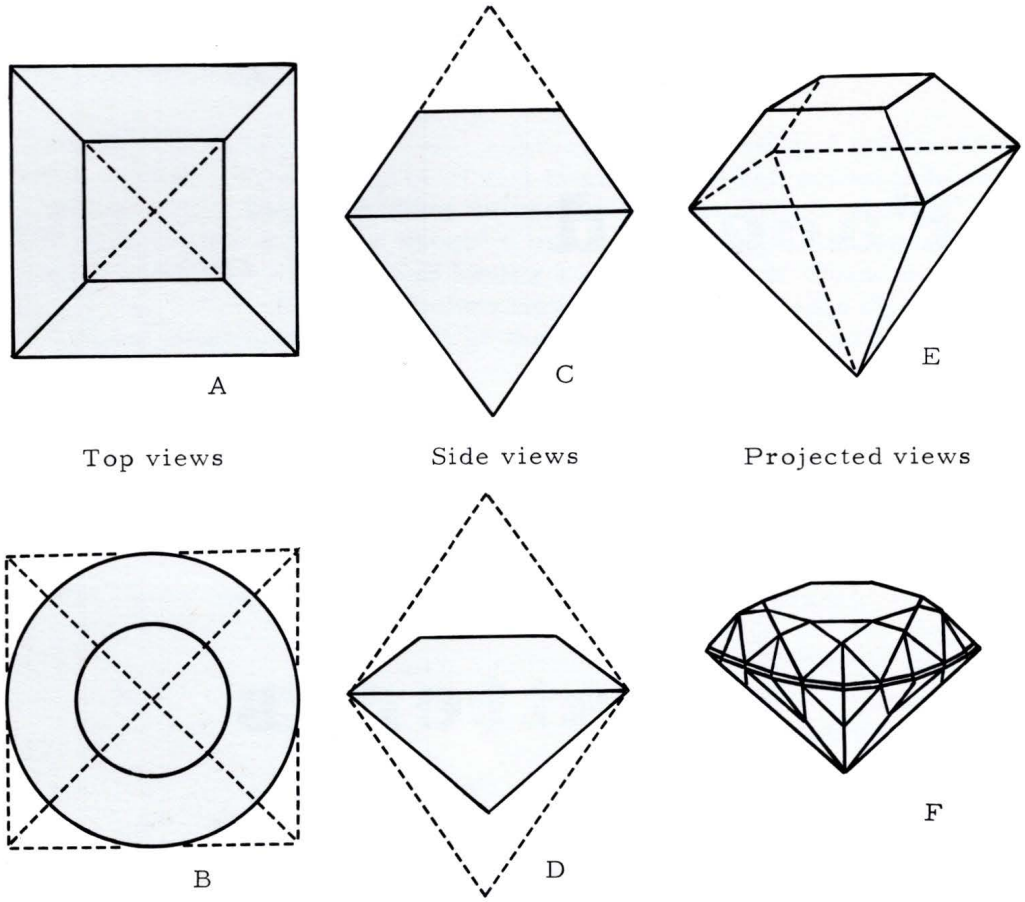


Figure 60. Derivation of the Table Cut and Brilliant Cut from the Octahedron.

round brilliant is very wasteful in comparison, but the quality of the gem is greatly improved. The wasted portions are shown by the dotted lines in B and D. The projected views, E and F, show the relative finished sizes.

Cutters of the table cut undoubtedly produced gems in varying degrees of perfection, and it was apparent from these differences in results that there must be a better method of bringing out the inherent beauty of gems. Near the end of the seventeenth century, at least 300 years after the advent of faceting, an Italian named Peruzzi devised a simple brilliant cut.* With this, the cutting of faceted gems entered a fabulous era which has persisted until the present. During this period facet cuts and faceting methods have greatly improved, with the outlook for the future being even brighter.

Advantages Of The Brilliant Cuts

The round brilliant is capable of gathering light equally from all sides; has no large facets to appear as dull spots; and compared to other cuts will usually give a greater yield of girdle width and carat weight from most rough. Another advantage of the round brilliant is in the order of the cutting of facets. In all cases, for the pavilion, cutting progresses successively from the culet to the

* See - Gems, Webster; page 352

girdle. This is not always true for the step or mixed cuts. The brilliant has no facets that must be fitted into areas which must be judged as to size beforehand. When one tries the mixed cuts, discussed later, it will be easily seen how the simplicity of the brilliant cut is an advantage, especially for the beginner.

In the crown of the round brilliants, as the Portuguese cut, facet cutting progresses from girdle to table. In others, cutting begins at the girdle, jumps to the table, and then progresses back to the girdle. Either is a simple process. Some faceters use the method of cutting the crown from table to girdle on all round stones, and get excellent results. The authors believe that the jump from girdle to table and progressing back to girdle is easier, at least for most brilliants.

The Standard Brilliant Cut

The best known of the round brilliants is the standard brilliant, Diagram 2. The overwhelming popularity of this cut, in use with the diamond, attests to the fact that it leaves little to be desired for light colored materials. This cut has been used so extensively for the diamond that the word brilliant has become almost synonymous with it. Even though the brilliant cut gives best results with colorless to light colored materials, dark materials of above average refractive index will also respond to it.

There are a number of direct modifications of the standard brilliant such as the highlight cut, Diagram 3; or the zircon cut, Diagram 4. Some of these variations are as simple as adding an extra row of facets near the girdle, or making ten main facets instead of the usual eight. With the ten mains are also ten stars and ten each of breaks right and left. Other variations, as in the zircon cut, facets or facet portions are split into smaller sizes in order to increase scintillation.

Brilliance has been defined in Chapter VI. Scintillation is, in reality, a form of brilliance, and is best described as the small, pin-point flashes of light that emanate from the facets of a gem. If we can produce a gem with many small facets, we now create more of these flashes, and by doing so, appear to increase brilliance. In actuality, we have only divided the potential brilliance into smaller portions. The human eye is not capable of discerning the size of very small light flashes, and as a result, we are conscious of a greater twinkling effect.

In view of the above, it is important that large stones or gem materials of low brilliance be cut, whenever practical, with some form of the brilliant that has an increased number of facets. Conversely, with the placing of a large number of facets on a small stone, the scintillation effect is such that some complain that they cannot see the stone. It is obvious that each person would look at this in a slightly different manner, but stones of less than one carat in weight are best cut as one of the simple brilliant cuts.

It is interesting that variations to increase scintillation are almost exclusively used for materials other than diamond. They are usually confined to the gems of lower refractive index which have the greatest need. The standard brilliant is evidently quite ample for the diamond and few attempts are made to improve the combination.

Simple Round Brilliants

Other round brilliants of simple form are popular. The eight-sided brilliant, and the petal cut, Diagram 1, are good examples. As can be seen, these are not round, but octagonal; but they are usually considered to be round. These simple cuts will not produce gems of high brilliance, but work well with small gems of medium to low refractive indices. Beginners will find them easy to execute. In the case of very small stones, these simple cuts are excellent.

The Multifacet Brilliants

There are many complex round brilliants which bear only superficial resemblance to the standard brilliant. These are called the multifacet brilliants. They have the advantage of increasing scintillation because of the many facets, but conversely, most have the disadvantage of increased stone depth. This undoubtedly accounts in part for these cuts not being used with diamond. Any increase in depth results in a problem in mounting the gem into jewelry. Also, the multifacet brilliant cuts need more depth of material in relation to girdle width. The diamond cutter has steadfastly refused to put more material into a stone than is necessary to produce a good gem.

The best known example of the multifacet brilliants is the Portuguese cut, Diagram 24. This cut produces excellent scintillation, but has extreme depth. It is generally relegated to collections or unusual jewelry, and is used with materials of medium to low refractive indices. A material of high refractive index would be best cut as a standard brilliant, or at most with only a slight variation. The amount of material necessary to produce a Portuguese cut might produce a standard brilliant of the same width, and at least one other smaller gem. Economical use of costly rough dictates against the multifacet cuts.

The use of the multifacet brilliants with the lower priced, light colored gem materials, cannot be overly exploited. The light colors are usually found in good supply in quartz, beryl, and topaz. These ordinarily sell at reasonable prices. It behooves the amateur to make the most of this, and the multifacet cuts are made to order for the situation. Most are reasonably easy to execute, with the Portuguese cut probably the easiest. It is good practice with the multifacet brilliants to make the culet facets long enough so that a measurement across the stone, at the upper tips of the culet facets, is about equal to the table width. This feature is discussed with the step cuts in Figure 63, Page 94.

This book includes other round cuts. Each has some virtue, and some have drawbacks; but if used within the scope intended, they will produce fine gems.

Size Of Gem Versus The Number Of Facets

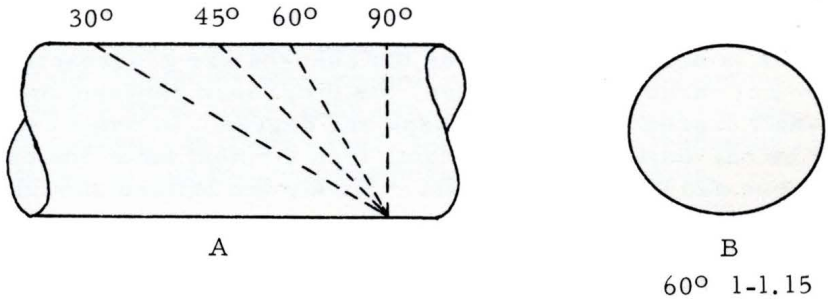
The number of facets placed on a stone should be in direct proportion to its size. It would be ridiculous to attempt to cut a gem of less than one carat as a Portuguese cut. Conversely, it would be a waste to cut a 150 carat gem as a standard brilliant. The former would be greatly overdone, and the latter would show little scintillation because of the large facet sizes.

There is a breaking point for size versus the number of facets. The authors have found that gems of low refractive index and up to two carats work nicely with the simple brilliants. A ten to twelve carat maximum for the standard brilliant seems reasonable before any modifications are needed. Above ten

carats the multifacet brilliants work very nicely, with the Portuguese cut having its best usage in the vicinity of twenty-five carats and upward. The only exceptions to the above rule would be the high refractive index materials. They will usually work well in a standard brilliant in sizes up to twenty carats. The obtaining of high R.I. rough in sizes that might produce larger gems is difficult. There certainly is no hard and fast rule forcing anyone to stay within any of the above limits, but the discerning faceter will notice the difference when he strays beyond them.

Variations In Brilliant Shape

The oval, pendeloque, and marquise, etc., Diagrams 11 to 14, are variations of the round brilliant. Examination of the diagrams will show that each is a variation on a circle. These cuts may be composed of portions of a circle, such as the marquise, or an elongated circle such as the oval. They are usually more intricate than the true round forms, as the faceting machine must be elevated for certain portions of the gem and lowered for others.



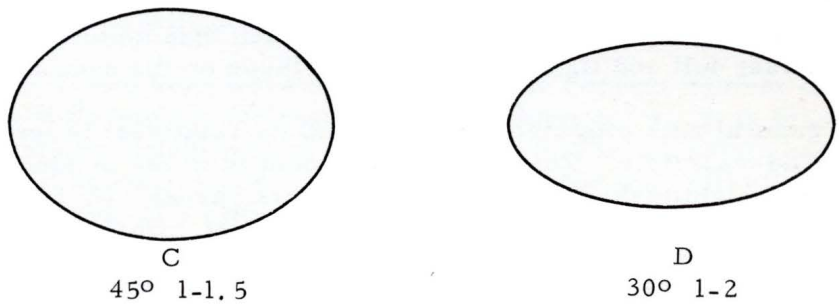


Figure 61.
Oval Outlines.

Figure 61 shows the outlines of three different shaped ovals, and how they are derived from a cylinder. The 45° oval, with dimensions of 1 to 1½, is the easiest to cut. No oval of any degree will exactly match any index gear for all break facets. It is possible that some break facets may match in some cases, but the cheater must be used for most others, sometimes quite extensively. In view of this mismatching, any reasonable oval shape may be done on any index gear (the 48 or 96 seems best) if the faceter will carefully note any use of the cheater. By this method any oval-shaped piece of rough can be economically cut.

When we deviate from a perfect circle, we are faced with the situation of the placement of either main or break facets at the widest part of the stone. A comparison of this is shown in Diagram 12. In some instances, such as the

illustration, it makes little difference which is done. In other cuts as the marquise or pendeloque, the mains must be to either side of the point. As one studies these cuts, he will notice that each calls for slightly different handling.

To easily cut an oval, the faceter must make a drawing of the stone in progress and record all angles and index settings as they are used. It must be understood that as the relative dimensions and curves of the oval change, the cutting angles must also change. As a general rule, there is a progressive change of angles as the curve changes. The cutting directions accompanying Diagram 11 indicate this sequence of progression. The change is slightly different for each stone and those given are only a guide.

The oval outline is the easiest of the variations on a circle to execute; but only after the faceter has gained reasonable proficiency on the round brilliant, is he in a position to understand the deviations that must be made in order to cut this variation. After the oval is mastered, the others are in order. It will be found that the whole group might be loosely classified in a "cut and inspect" group. Each facet or set of facets as a turn is rounded will be slightly different than the previous set. The best way of determining the correct angle, etc., is by careful experimental cutting. Polishing follows easily if good notes are kept. The process is not blind groping as the changes are progressive and depend upon the degree of curve. As examples, the difference between successive facets may be one-half degree each, or perhaps one degree. In other cases the second facet may be one-half degree different, then the next facet one degree, with the third facet one and one-half degrees. Quickly the pattern should become apparent, and it will deviate slightly, if at all.

This group of brilliant variations will work well with the colorless gems, but as any color increases, the cuts show an undesirable feature. All oblong brilliants tend to have larger facets on the mid-point of the stone (along the longer sides), an inherent characteristic forced upon it by the elongation of a circle. These larger facets exhibit less scintillation than smaller ones, and appear somewhat dull and lighter in color than those on the ends of the gem.

A general rule might be, the oval (and its relatives) is less desirable for colored materials. This is more pronounced in the medium hues. For example, an oval might make a good gem with a dark garnet. It, however, would be better than the same cut in medium colored amethyst. On the other hand, the dark garnet would be better as a round brilliant, and still better as a shallow rectangular cut. Experience with dark materials will quickly give the cutter a basis on which to proceed.

Accompanying the deficiency in regard to color is the cutting of pleochroic materials into ovals. The brilliance of certain pleochroic minerals is greatly affected by the way light travels in the gem. In some cases, light is completely absorbed along one axis, and any oval cut from this material may be dark in portions. Pleochroic materials are better cut as rectangles.

THE STEP CUTS

Gems with long, somewhat rectangular facets are classed in a group known as the step cuts. The name stems from the fact that these facets resemble the stairs of a stairway. Sometimes the name trap cut is used for this group. Trap is the Dutch word for staircase. Regardless of which term is used, the reference is good, and makes a good descriptive name.

The proportional dimensions of rectangles have been of concern to artists for centuries. The ancient Greeks expounded, and used a set of rectangle proportions that are still in use today. They determined that the ratios of one to three, two to three, and three to five were the most ideal from a standpoint of artistic balance. As a faceted gem falls within this realm, the faceter would be wise to use these ratios as much as possible.

The second set of proportions is the most pleasing, and is often the easiest to accomplish when faceting. Coupled with this is the fact that the one to three rectangle necessitates a very unusual shaped piece of rough in that it must be long and narrow. The only common shape of this kind is a slender crystal such as tourmaline or beryl. The three to five rectangle is somewhat better and some irregular pieces as well as slender crystals might fit it. Most of the nearly rectangular pieces of faceting rough commonly measure about one and one-half times as long as wide, and this proportional ratio is usually saving of material.

After the art of faceting emerged from the stage of haphazard placement of facets over a gem, the step cuts were among the first symmetrically shaped stones. The forerunner of these was the table cut shown in Figure 60, Page 86. The cutting of long rectangular facets was possible on primitive equipment, with the parallel alignment of the facet sides being done by eye. Most of the step cuts are rectangular in outline. In many cases, the corners are truncated to give the gem more brilliance, and to lower the possibility of chipping.

Emphasis On Color

The step cuts do not enhance the brilliance of gem materials. The brilliant cuts are best for this effect. The step cuts find greatest usage with colored materials, and are especially advantageous with the light to medium colors. Used correctly, the step cuts will deepen the color of a gem.

All step cut diagrams shown here were designed with the correct number of facet rows and degree differentials for materials of medium color. It is fully realized that there could be differences of opinion as to what is a medium hue. For our purposes it will be considered to be the deepest color that will allow the easy visibility of the far side of a piece of rough. When the rough must be viewed against a light in order to see the far side, the color is considered dark. If a very strong light is necessary in order to get light through to see clarity or color, the term very dark is used. Any hue that is appreciably less than medium is to be considered as light, with very light being relegated to a nearly colorless material.

Angles Of The Step Cuts

The facet angles of step cut gems differ from the round brilliants in a number of respects. The pavilion angles are usually in intervals of ten degrees. The facets at the culet are cut at the culet angle for the material. Under normal conditions the facet row above is cut at ten degrees greater, and the row at the girdle is cut at twenty degrees above the culet angle.

The crown facets of the step cuts are also cut at regular intervals. The mid-facet row is assumed to be the main, and is cut at the crown angle. The facet row at the girdle is cut at fifteen degrees greater than the crown angle. The table is surrounded by a row of facets that is cut at fifteen degrees less than the

crown angle. In all step cut diagrams herein, the crowns show this fifteen degree interval. Many other step cut diagrams in the literature show a thirteen degree interval between the main and girdle facets, and a fifteen degree interval between the mains and the facets surrounding the table. The fifteen degree interval recommended here for both cases was chosen for continuity and accuracy. It is a simple matter for the faceter to remember that the pavilion has a ten degree angular interval, and that the crown has a fifteen degree interval.

The fifteen degree interval between the main facets, and those next to the table, matches that of the same facets (main and star) on the standard brilliant.

Deepening Of Color

The deepening of color in step cut gems (compared to the standard brilliant) is accomplished by the greater depth of the stone. This greater depth is the result of the three ten degree angular intervals. The normal step cut stone as shown in Diagram 26 is about as deep as it is wide. The standard brilliant is about three-fourths as deep as the width. Some of the multifacet brilliants are about the same proportions as the step cuts and will accomplish nearly the same deepening of color.

Light traveling this greater stone depth takes on a deeper hue by virtue of the longer time it is subjected to color absorption. The step cuts will darken almost any hue if the necessary stone depth is within the realm of reason.

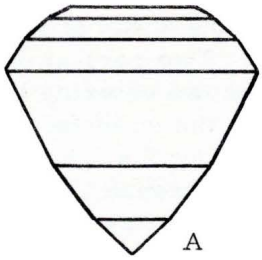
Figure 62 shows outlines (end view) of step cut stones with various depths. At A is the depth and degree interval for medium color. When the hue is light, B is best, and in the case of very light color, C might be used. It will be seen that depth is increased by adding another facet row, and at the same time altering the facet degree differential. The addition of facet rows has the effect of increasing scintillation as well as depth.

Excessive deepening of stones finally runs into limitations that will nullify any further gains. First, the gem may become so deep that it would be out of balance and virtually impossible to properly display, or mount into jewelry. Second, the increasing of numbers of facet rows may entail an accompanying reduction of degree intervals. If the interval is below five degrees, there is difficulty in visually separating the individual facets during the cutting process. A pair of facets lying in the same plane with only a few degrees separating them will appear, as far as light reflection is concerned, as if they were a single facet. Third, the excessive deepening of a stone will call for rough of a correspondingly deep shape which may be difficult to obtain, or wasteful to produce from most rough.

It is difficult under these circumstances to maintain the two to one pavilion and crown depth relationships. As the stone becomes deeper in relation to width, the pavilion to crown ratio will approach three to one. If the faceter will stay within the maximum limits of five facet rows and a minimum of a five degree interval between them, he will find the execution of these cuts to be easy and the results satisfactory.

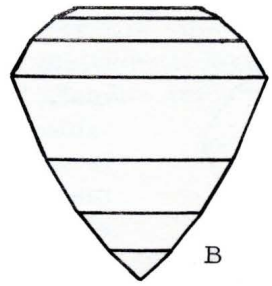
Dark Colored Materials

Any gem material of dark color forces the faceter to place brilliance in a secondary position. Here he is concerned with getting as much light as is



A

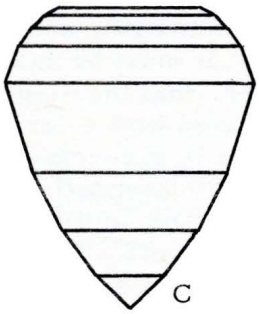
Standard step cut
Pavilion-three 10° steps
Crown-three 15° steps
Width=1 - Depth=1



B

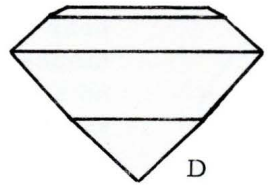
Deepened step cut
Pavilion-four 8° steps
Crown-three 18° steps
Width=1 - Depth=1.1

Figure 62.
Comparative Step Cut Depths.



C

Very deep step cut
Pavilion-four 10° steps
Crown-four 15° steps
Width=1 - Depth=1.2



D

Shallow step cut
Pavilion-two 5° steps
Crown-two 15° steps
Width=1 - depth=.7

possible through the gem in order to show the color. To accomplish this, the direct opposite of the color deepening process is employed. The pavilion should be as shallow as is needed, as in 62D. In cases of very dark materials, the culet angle may be reduced to the critical angle, or even below. It is possible that only one pavilion facet may be used, and usually the maximum is two. The interval between the two facets may be reduced to below five degrees if desired, but again it is not much better than a single facet.

Table Size

The step cuts are designed for colored materials, and there is no great emphasis placed upon brilliance. It follows that the table size of 50% of the girdle width is not of great importance. It has been argued that the table should not be larger than the horizontal width measured across the upper edge of the culet facets. This would nearly always be less than 50% of the girdle width. The argument is a good one, as the greatest brilliance could be attained. This is

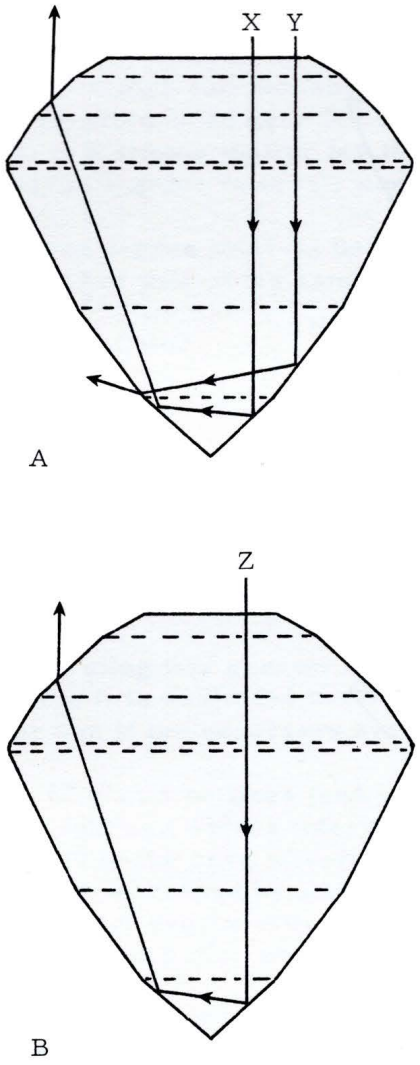


Figure 63. Two Table Widths for Step Cut Gems.

shown in Figure 63.

The table width of 50% of the girdle width is shown at A. Two rays at normal, X and Y, are shown entering the table. Ray X strikes the culet facet and is totally reflected. Ray Y strikes the main facet and is lost through the opposite side of the pavilion. Ray Y is the basis for the making of a smaller table as shown at B. In this situation, rays at normal can strike only the culet facets, and are totally reflected as in ray Z. Ray Z is identical to ray X. It can be seen that the crown of B is higher than that of A. To accomplish the smaller table, the crown must be higher.

A step cut stone cut with this smaller table would have a correspondingly greater crown to refract light, and appear more brilliant. It must be again emphasized, however, that the step cuts as a group are best used with colored stones, and brilliance is secondary.

It then appears that if the color is to be deepened, the above argument is good, as it may deepen the crown slightly. If the color is to be made lighter as shown in 62D, it is imperative that the table be large in order to gather as much light as possible. The choice in this matter is left to the faceter. There are good and undesirable effects to both the large and small table, and in most instances, it appears to make little difference either way.

Step Cut Crowns Correspond To The Pavilion

When controlling color with the step cuts, the crown is made higher or shallower in nearly the same relationship to the pavilion. This is shown in Figure 62. If this were not done, the color change might not be complete, and most important, the stone would be out of balance.

Increasing the height of the crown for lighter colors is comparatively easy by simply adding a number of degrees to the interval between each facet row; or by adding another row and adjusting the angles. The angle of the facet row next to the girdle is in the vicinity of fifty-five degrees, and the facet row at the table is in the vicinity of twenty-five degrees. These should seldom be changed, but the various angle intervals between any added rows may be made smaller. The usual interval is about fifteen degrees; this may be lowered to ten degrees, or even less, to accomodate added facet rows.

When deep color is being reduced, the situation is different. If the interval is reduced as for the pavilion, the crown facets, especially the stars, may look little different than the table. To solve this, the best course is to first remove the facet row next to the table and then reduce degree intervals. As in the pavilion, the depth of color will determine the amount of decrease of angle of any crown facet.

Freeform Gems

The step cut, Diagram 26, is admirably suited to be varied to produce the freeform. A number of freeform outlines are shown in Figure 64. The view is

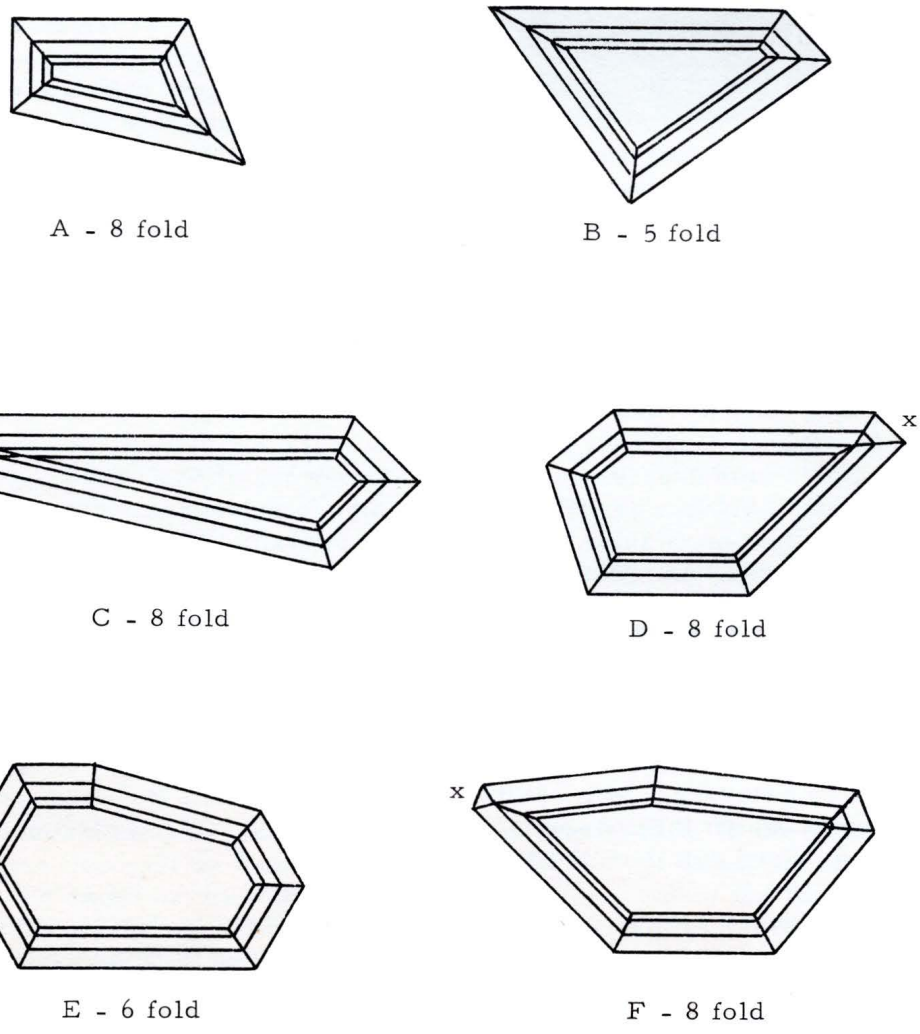


Figure 64. Outlines of Freeform Gems.

from above the table. Outline A is very simple, with the others showing varying degrees of complexity. Each is indicated as to the symmetry of the index needed to achieve the figure. The x on D and F indicates the lack of crown facets on the corner due to the acute angle. This type of cut has some excellent advantages. Most important, it may be used to make a gem that will follow the irregular outline of a piece of rough. It is possible to gain a nearly double carat yield through the use of a freeform over one of the conventional symmetrical shapes. A well balanced (not symmetrical) freeform placed in a setting of compatible

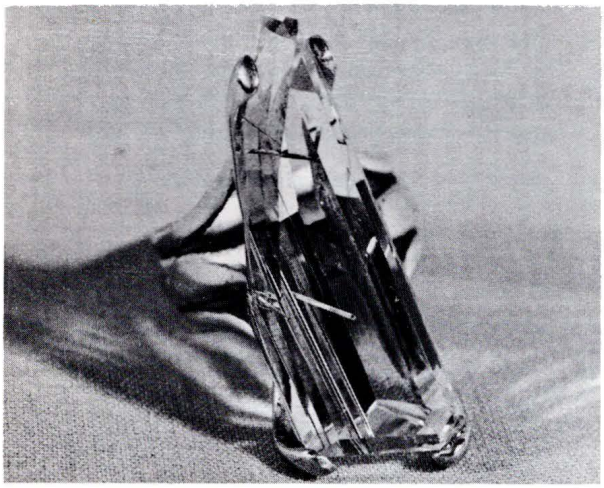


Figure 65. A Freeform Gem in Jewelry.

design can make a very attractive piece of jewelry.

A disadvantage of the freeform is that, in many cases, the angles of the girdle outline may meet in a way that a lesser amount of brilliance is exhibited. This is a point to consider, but it must be remembered that such a cut is designed to save rough material and enhance its color. Another problem encountered is the acute angle of some of the points on the girdle outline. These may chip during cutting as well as subsequent handling. This last deficiency is also true of the simple step cut, the marquise, and others. In the final analysis, the advantages outweigh the disadvantages. The cut should be relegated to the reasonably priced materials of low to medium refractive index. It is difficult to conceive of one cutting a high refractive index material as a freeform.

The planning and execution of a freeform is discussed in Chapter IX in the section on grinding to final shape. It is also covered in the chapter devoted to cutting of facets.

THE MIXED CUTS

A number of facet cuts, that for the want of a better name, are classified as mixed cuts. The name is derived from the fact that the pavilion is usually of the step cut type, and the crown is formed of triangular facets. Diagram 34 is a good example of this type of cut. It can be readily seen that, except for facet shape, the crown bears only a remote resemblance to the round brilliants. The crown of the scissors and shuttle cuts are further examples of this lack of resemblance. These have been included in the mixed cuts simply because of the lack of a better category. Some authors class these under the broad term of "fancy shapes", which indeed some of them are; but as this term means no more than the term mixed cut, it will not be used here.

There is a tendency for the more experienced faceters to devise some interesting new cuts. Most of these fall into this broad class of mixed cuts. It is conceivable that in the future there may come into use some new terms to better classify this heterogeneous group.

Uses Of The Mixed Cuts

The mixed cuts work nicely with colorless materials as well as the colored. The use of the medium to dark hues is preferred. The mixed cuts are quite commonly used by the native cutters of Europe and the Orient. They are usually working with colored materials such as the spinels, rubies, garnets, tourmalines, etc., and the results are satisfactory.

Again the factor of refractive index would determine the use of this group of cuts instead of a brilliant. Any rough of high refractive index should first be

considered as a brilliant, especially if the color is light. For the deeper colors, regardless of the refractive index, the mixed cuts may be considered.

TRANSPOSING NUMBERED DIAGRAMS

There are many facet cut diagrams in the literature, and practically all of them have the various facet positions indicated numerically as part of a circle. The divisions of the circle correspond to index divisions and in these cases are 32, 64, and 96 for eight and sixteen-fold symmetry; 40 and 80 for five and ten-fold symmetry; and 48 and 96 for six and twelve-fold symmetry.

When cutting a stone of eight-fold symmetry, such as the standard brilliant, using a 64 index, the mains will be every eight divisions beginning with setting number 64. Stars will also be every eight divisions, but starting with setting number 4. Breaks right would again be every eight divisions beginning with setting number 2, and breaks left would start with number 6. This cut would use only half of the 64 settings available. If the stone were sixteen-fold and had stars and two breaks, each facet would fall every four divisions. Mains would again start on setting 64. This cut would use all settings.

The transposing of these numbers to the classes of symmetry and the facet names may be facilitated by the use of the transposition charts in Figures 66, 67, and 68. Each is similar to the others, but as they are three basic types of symmetry, all have individual differences.

Some makes of faceting machines are calibrated into facet names rather than by numbers. These are in the symmetrical divisions, and here the task is no problem when the transposing charts are used. Those machines that use the numbering system may be marked with a suitable color code that will identify the various facet positions. This will greatly simplify the "sea" of numbers on the larger indexes. Other machines may use different systems. On any machine the main facets are cut at regular divisions of the index, so it is simple to call these main settings; others may be called break settings, star settings, etc.

Symmetry Transposition Charts (Figures 66, 67, & 68)

The vertical line above center in each chart, marked ID, is the index division line. On this line will be found the maximum number of divisions of each band. These are the same as the maximum number of divisions of the indexing device of the faceting machine. The horizontal line to the right of center, marked Sym., is the symmetry line, and denotes the symmetry for each band. In each case the outer band does not have a symmetry number that is a multiple of the basic symmetry of the chart. Because of this incomplete symmetry, the outer ring (or rings) is separated from the balance of the chart by a heavy line.

Each chart has the numbered settings also indicated as facet names. The main and star settings are marked M and S respectively. The breaks right and left have no indicators, but these may be easily discerned by noting on which side of the main that they lie.

Each chart is an equally divided series of circles. The center circle is divided into a minimum number of divisions. These are the 5, 6, and 8 basic symmetries. Each larger band is further divided into double the number of settings of the band it encloses. This doubling is continued to the outer band.

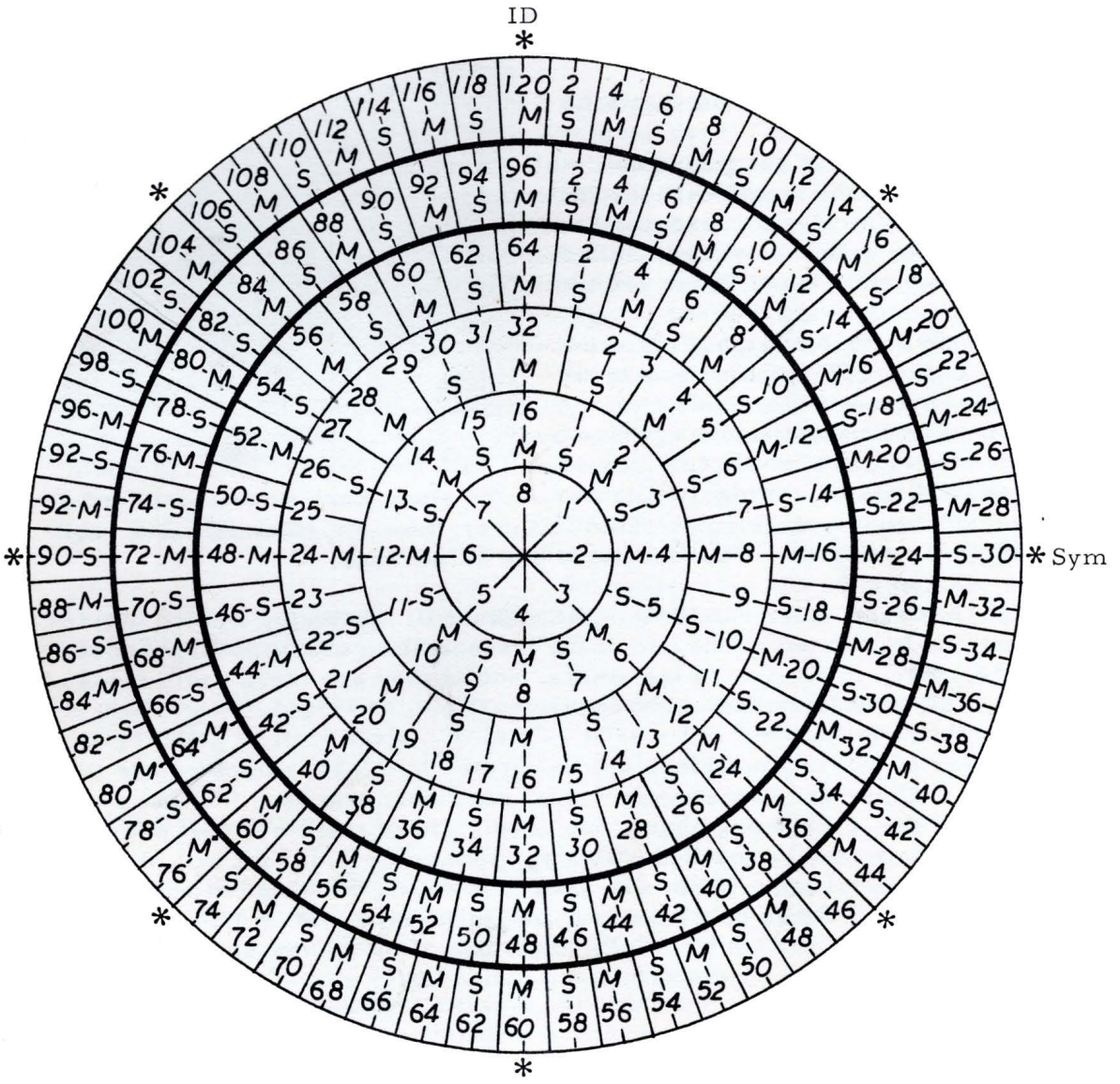


Figure 66. The Eight-fold Transposition Chart.

This chart will transpose eight-fold diagrams and index devices. As an example; if the diagram for a facet cut is shown on a 64 division chart, it will transpose to a 96 division index only if the even numbers of the 64 series are called for. Notice that settings 1, 3, 5, 7, etc. of the 64 band do not match any point of the 96 band. The diagram exemplified above could also be done on a 32 division index if again only the even numbers of the 64 index were called for. The 96 index is accurate only for 32 positions or less. The 120 index will transpose accurately only for a stone with eight positions, such as the emerald cut.

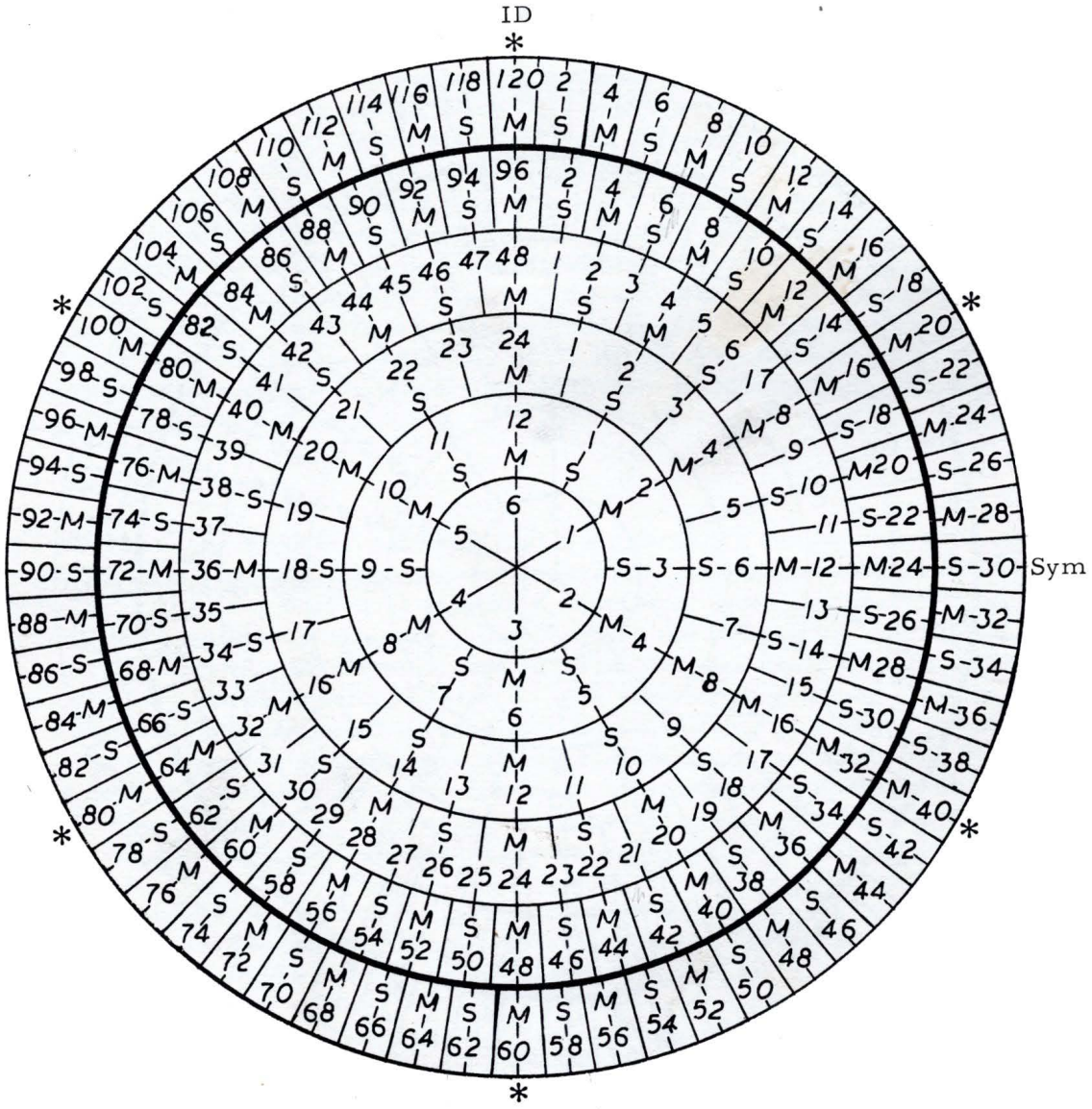


Figure 67. The Six-fold Transposition Chart.

This chart will transpose similarly to the eight-fold chart, except that it is in divisions of six. It will assist in cutting equi-dimensional triangular gems. These cannot be accurately done on an index of other symmetry. To cut a triangular gem, use alternate asterisk (*) lines that radiate from the center. These will be the main facets, with star facets using the three remaining asterisk lines. Break facets, if used, will be on the lines midpoint between main and star settings. A triangular gem is three-fold symmetry. The 120 index would be adequate for the cut exemplified above, but would not be adequate for a hexagonal gem needing 48 settings.

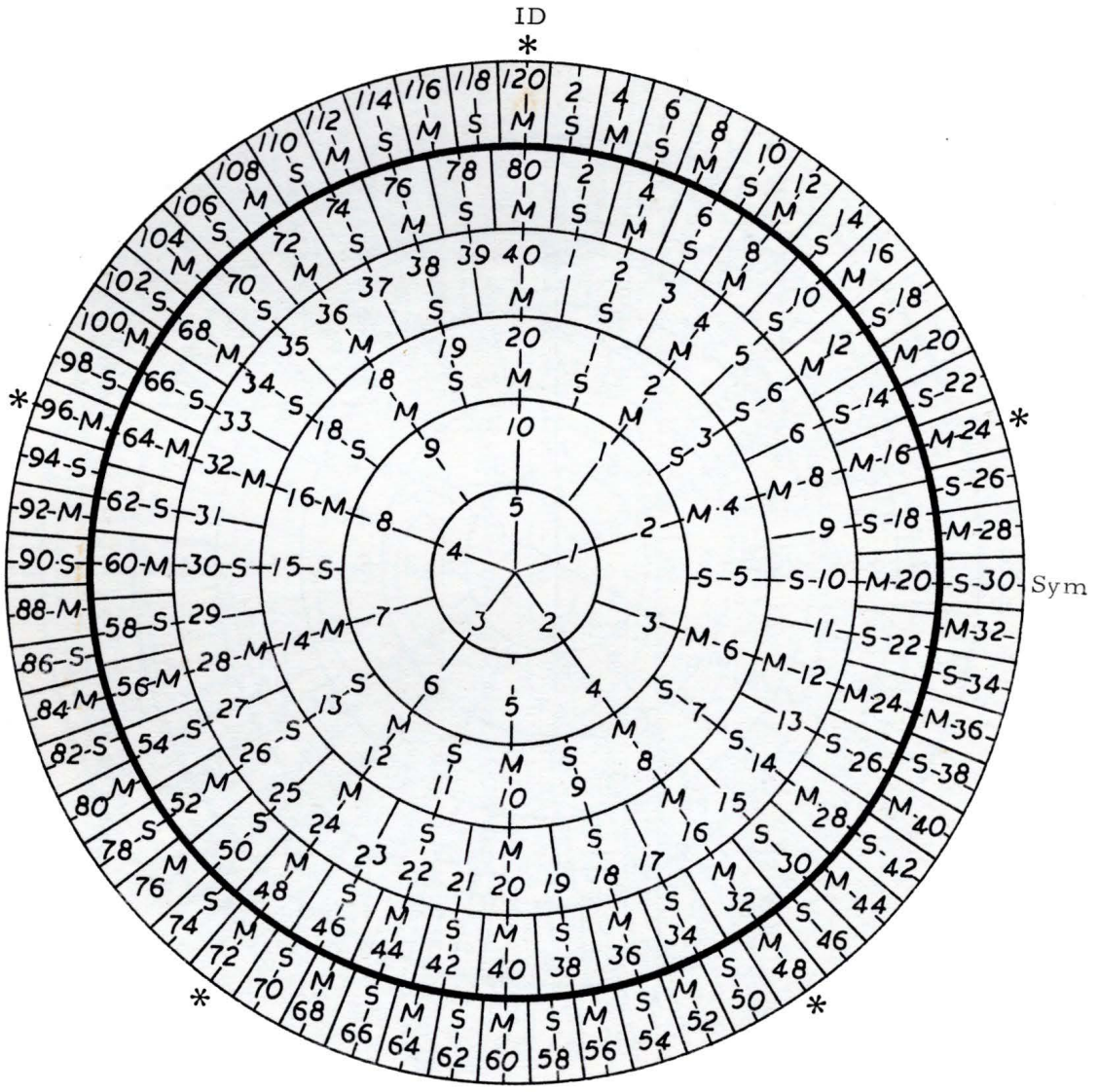


Figure 68. The Five-fold Transposition Chart.

This chart will transpose similarly to the eight-fold and six-fold charts, except that it is in divisions of five. The five-fold class of symmetry is somewhat limited as five is an asymmetrical figure, and this is reflected in that the symmetry line does not extend inward past the 20 division band. This chart may be used to plan some very interesting pentagonal shaped gems. When turning the gem to do the crown, it must be rotated 72° in order to gain correct realignment. With this symmetry, the 120 division index is adequate for a stone calling for 40 settings, but not one needing 80 settings.

The outer band is divisible into the basic symmetry of the inner bands, but is not divisible by the ID number of all bands. Outside of the outer band are a number of asterisks (*) which denote the minimum symmetry for the chart. These asterisks lie at the end of a line that intersects only main settings to the center of the chart. Each chart also has lines that run from the outer edge and to (but not into) the inner circle. These are either main, break, or star settings, depending upon which band they intersect. On the 6 fold symmetry chart these accessory radial lines are only main and star settings, with the break settings not running to the outer circle. For the 8 fold transposition chart the entire settings of the 32 division band (all mains, stars, and breaks) are represented in the 64 and 96 division bands, but not the 120. In other words, the outer bands will not transpose for any other except the central band. This central band is usable only for stones such as the emerald cut. The 96 index will do for 32 divisions, but not for 64.

Recommended Indexes

The above inconsistencies point out that a single index device with a large number of divisions will not transpose accurately for more than one type of symmetry. The best answer is to have a number of index devices for each machine. The authors would like to recommend the following: for eight-fold symmetry, a 64 and a 32 division device. The 32 index device might seem to be duplication, but as previously stated, it is simpler than the 64 division unit. Only 32 settings are needed to cut the standard brilliant, and as the greatest number of gems cut by the amateur will be the standard brilliant, or closely related cuts, the smaller number of settings offers greater speed and accuracy. The ordinary rectangular cuts use only eight or sixteen settings. To repeat, it seems a shame that many manufacturers do not offer 32 division index devices.

For five-fold symmetry a 40 or 80 position device is necessary in order to do five and ten division stones. The 80 division index is most common; but, again, the 40 will offer the greatest freedom from error.

Stones of six and multiples of six-fold symmetry are best cut on the 48 and 96 division devices. The simplicity of the 48 again holds for the least complex stones. The 96 is most common, and will assist in doing the greater number of cuts. As may be seen from the symmetry transposition charts, the 120 division device will partially transpose both the five and six-fold symmetry, and can be a useful accessory if the others are not available.

If one is forced to settle on only one index, the 96 is the best choice. This may be seen on the transposition charts. The 96 index will transpose for eight (up to 32 positions), and will also do the 24 and 48 multiples of six. It will not correctly transpose for a five-fold diagram, nor eight-fold greater than 32 positions.

It must be pointed out that almost any index can be used to cut almost any reasonably shaped stone, but one needs to keep careful notes as to the settings used and the amount of cheat required. Stones done in this manner will not be perfectly equi-dimensional, but if they are carefully planned they can be excellent gems. To use any of the three charts start with the index division line (ID). The numbered and named settings will be found completely around the band. If the number of facets on the diagram calls for more settings than the index device on hand, the cut in question cannot be done.

FOLLOWING FACET CUT DIAGRAMS

All facet cut diagrams are systemized in reference to symmetrical groupings of facets. They are classed according to types of symmetry which may be four, five, six, eight, ten, twelve, or sixteen fold. The standard brilliant is an example of eight-fold symmetry. It has eight groups of facets with a main facet as a central unit of each group. The Portuguese cut has sixteen-fold symmetry with sixteen groups of facets.

If we look at the pavilion of the standard brilliant, Diagram 2, we see that it has eight mains (M), each with a break facet to either side. The break facet to the right is known as breaks right (R), and the facet to the left is known as breaks left (L). The crown of the standard brilliant is slightly different in that it has another type facet, the star facet (S). The main is again flanked by the breaks left and right, but lying above the breaks and between mains is a star facet. The star facets surround the table.

The pavilion of the Portuguese cut (Diagram 25) is different from the standard brilliant. The sixteen mains have only one break lying between them and adjacent mains. There are now other mains, known as secondary mains, and are designated as M' and m. The facets at the culet, which are different from the above facets, are the culet facets and are designated as C.

The crown is similar to the pavilion in that it has single breaks and three types of mains (M, M', & m). Like the standard brilliant it has star facets surrounding the table. Each of these lies between secondary mains.

A cut of eight-fold symmetry has eight mains, and may or may not have stars, breaks, secondary mains, or any other facets. The same is true for other types of symmetry.

Think In Terms Of Facet Names

The faceter will find it to his advantage to think in terms of facet names rather than numbers. If he thinks in terms of so many main facets (the class of symmetry), each surrounded by other facets that are adjacent, he now has a better grasp of how the cut is arranged, and what the final gem will look like. Determining the class of symmetry is usually simple. If, on the pavilion, eight mains touch the girdle, it is of eight-fold symmetry. The same would hold true for other classes of symmetry. There are exceptions to this in that some cuts, such as the vertical split mains cut (Diagram 6), do not have mains. Instead, each is represented as two facets, or may have the main facets split into two facets near the girdle. These are unusual, and when encountered the break or star facets will give the clue to symmetry. The mixed cuts are made up of greatly different types of facets, with the symmetry somewhat difficult to analyze.

The designations of mains, stars, and breaks are used in most of the diagrams to denote types of facets. Exceptions are when another name is used to better describe an unusual facet. As an example, on the scissors cut (Diagram 36), facets to either side of the mains are called wing facets. The term is more descriptive, but wing facets are usually cut on the same settings as break facets.

CUTTING DIRECTIONS

The cutting directions accompanying the facet cut diagrams herein are self explanatory. This is true of most diagrams in the literature, but those shown here are a bit different. A short discussion of them is in order.

The facets are denoted in the symmetry unit, using the first letter of the name of the facet. A facet marked M is a main facet. The use of M' or m would indicate a secondary main. In some cases where there are more than one set of mains, or none, the facets touching the culet are indicated as C. The star facet is indicated by S, with S' and s indicating a secondary situation. A break facet is denoted as B, when there is a single break per unit. A single break is usually cut on star settings. When the breaks are in pairs L will indicate breaks left, and R breaks right. Any further designations are covered in the directions for the cut in which they appear.

These letter designations cover one set of facets. This is usually the group to the right of upper center. On occasion one or more facets of an adjacent group are lettered to further clarify. The designation M on a single facet indicates that all other facets of the same size and shape, that are situated in the same position, are also mains. This is true for any other type of facet. There may be only two such facets on a stone, or four, six, eight, twelve, sixteen, etc. Each of the groupings ordinarily surrounds a main facet; and, if so, it usually follows that there are as many of any designation as there are main facets.

The Cutting Order

The numerical designations, usually to the right of lower center, indicate the cutting order. A facet (row) marked 1 is cut first, that marked 2 is cut second, etc. In some cases a pair of split facets marked M and m or M and M' are numbered singly. The portion marked M is cut first. The remainder of the pair is cut immediately following. There is an angular difference between the two which must be observed when cut according to the diagram. It is possible instead to cut this as a single facet with the angle at a midpoint between the two.

The sequence of the cutting order with each diagram is not always mandatory, but it is recommended that it be followed; at least until the faceter has gained a reasonably good technique. In some cases it is absolutely mandatory that a certain facet be cut following another. If this is not done, symmetry and balance would not be possible, and much improvising might be necessary to complete the gem. The polishing order is not mandatory, and is discussed in Chapter XI.

Cutting Angles

It will be noticed that no cutting angles are shown on most of the facet diagrams. Instead, there is a reference to either a culet angle or a crown angle. Some facets are cut at a number of degrees greater or less than the culet or crown angles. These angles are variable from species to species and are listed in the species descriptions in Appendix I. A referral to the species descriptions should be made before cutting any gem. This will determine the culet and crown angles, plus other important information.

Work Sheet

The above information, and other subsequent information that may appear

Date	Number
Species	Origin
Rough Wt.	Finished Wt.
Index used	Type cut
Critical angle	
Pavilion angles	
Crown angles	
Polishing lap	
Polishing agent	
Remarks:	

Figure 69. Faceting Work Sheet.

during cutting, should be transferred to a work sheet as in Figure 69.

A work sheet similar to this (about 4 x 5 inches) is invaluable in keeping basic information during the faceting process. The portion for remarks can be used to show amounts of cheat, unusual angles, etc. The use of such a record, which may be simplified or elaborated upon, is recommended. Relying on memory for cutting angles, indexing, or other situations is courting trouble. The lower portion of the work sheet is suitable for a drawing of the stone on which to note angles, errors, adjustments, etc. This lower portion may be removed if the sheet is filed as a gem record.

Layout Of Diagrams

The faceting diagrams and instructions offered in this chapter are laid out differently than others in the literature. Differences, such as lack of cutting angles and index position numbers, have been pointed out. The most significant difference is in the arrangement of the drawings. These are arranged across the top of the page, with the pavilion to the left, the side view in the center, and the crown to the right. The left column pertains to the pavilion and the right column to the crown.

The index suggested for each diagram is the smallest that may be used. These usually are 32, 40, or 48. Any other index of larger number may be used if the listed index number will divide evenly into the number of the index on hand. When the quotient after division is two, skip one setting, and use the second. When the quotient is three, skip two settings, and use the third. If it is found that the quotient is not a whole number, such as 96 divided by 64, the transposition is not possible.

THE FACETING DIAGRAMS

This book contains many references to the brilliant cuts. Most of them are round, but there are some cuts which are square or nearly so that fall into the class of brilliants. On the other hand, there are also a few round stones that are cut in step form.

Faceting terminology is not completely adequate, and as a result there will be those that will disagree with some of the terms used here. The term brilliant includes any equidimensional shape -- round, square, triangular, or other. These cuts are composed of relatively small triangular or kite-shaped facets, covering both pavilion and crown. The step cuts, composed of more or less rectangular facets on both the pavilion and crown, are usually rectangular, but

some are round, triangular, etc. The mixed cuts include those with a step pavilion and a crown of triangular facets. In a few cases this situation is reversed, or both pavilion and crown have both rectangular and triangular facets. The mixed cuts also contain a few that do not satisfactorily fit the other classifications.

SECTION I

Diagrams 1 to 10 -- The Simple Round Brilliants

This group is an excellent starting point for a beginning faceter. After he has progressed beyond this stage, he will find himself frequently returning to it. The simple round brilliants will do the most for a large segment of the gem minerals, and the faceter will find that his greatest number of stones will be of this type.

The standard brilliant will be done with the greatest frequency. This does not imply that a faceter should concentrate on the standard brilliant, or exclude the step or mixed cuts. It is the intention of the authors to get the faceter to try as many types of cuts as possible. It is an inescapable truth that most gem materials will produce better gems as one of the round brilliants. A greater number of brilliant cuts have been purposely included because of the situation noted above, but there has been an attempt to give a balanced grouping of all types.

Diagram 1, The Petal Cut And The Eight-sided Brilliant

The petal cut is excellent for stones in the vicinity of five millimeters in width or smaller. Larger stones are pleasing but lack brilliance and scintillation. It is a simple cut offering no complications.

The eight-sided brilliant is well suited for stones of about ten millimeters in width and smaller. It is the cut used for the step by step cutting directions in Chapter X. The directions given in the text differ from those on the diagram in that the text suggests cutting only four alternate pavilion mains as the first step. This will square and center the culet before placing the other main facets. For the beginner this is the best method.

The preform for either of the eight-sided brilliants is identical to that of the standard brilliant.

Diagram 2, The Standard Brilliant

This is the best cut when maximum brilliance is desired of medium to high R.I. material. It also produces the shallowest possible round gem. Its greatest use is with the colorless materials, but light to medium colors are very satisfactory. Dark colors of the very high R.I. materials will often make fine standard brilliant gems.

This cut is not ordinarily suited to stones much over fifteen millimeters in width. The low R.I. materials work well at 12 millimeters and below; the medium R.I. materials work very nicely in widths up to fifteen millimeters and the high R.I. gem materials will work well in sizes up to twenty millimeters. The fifteen millimeter limitation is a good one to observe in most cases.

The preform should be the true conical shape shown in Figure 82B, Page 190.

Diagram 3, Variations Of The Standard Brilliant

Other variations of the standard brilliant are shown elsewhere, but they call for extensive modifications of angles or cutting procedure. The four variations here call for the addition of facets to the regular pattern, with only small angle changes, and no great altering of the cutting procedure.

The ten and twelve-fold variations add scintillation, without increasing stone depth. Both will work well with the low R.I. materials, but are of no advantage with the high R.I. materials as they often appear to glow rather than have the pleasing twinkle that is expected from faceted stones.

The highlight version is interesting in that the addition of the extra facets at the junction of the normal break facets gives a pronounced rise in scintillation. These additional facets tend to capture and return some light that otherwise would be lost.

The diamond cut variation has longer pavilion break facets.

The preform for these variations is the same as the standard brilliant.

Diagram 4, The Zircon Cut

This was, as the name implies, designed to increase the light return of zircon so that these gems would be comparable to diamonds. Regardless of the deception intended, this modification of the standard brilliant is a good one. It is a slightly deeper cut, but this should be of little consequence.

This cut can be used to good advantage with medium to high R.I. materials from colorless to medium color. As it will tend to slightly deepen color hues, it may not be good with deep colored material. The cut will work well with lower refractive indices, especially with the light colors; but the results do not compare to those with higher refractive indices.

The preform for the zircon cut should have a slightly deeper pavilion than for the standard brilliant.

Diagram 5, Horizontal Split Mains Brilliant

This modification of the standard brilliant adds some scintillation, but also adds to the depth of the stone. This extra depth can be of advantage in deepening light colored material, but can be disadvantageous if the stone is to be set in a commercial mounting. The cut works well with nearly any type of material, with the darker hues excepted.

The preform should be slightly deeper than for the standard brilliant, with a slight curve. It should not be as deep as that for the multifacet brilliants.

Diagram 6, Vertical Split Mains Brilliant

This is an excellent variation of the standard brilliant that enhances scintillation, but does not increase stone depth. A 64 index is necessary to produce this cut; it will not satisfactorily cut on a 96 index, unless it is changed to twelve-fold symmetry.

The vertical split mains brilliant will work nicely with all materials except those of the highest refractive indices. Nearly all color hues seem to be equally responsive. The millimeter limitations are about 15% higher than those for the standard brilliant.

The preform should be of the standard brilliant type.

Diagram 7, The Rose Cuts

The rose cuts were designed for small stones, to be set point (apex) upright around large gems. They later evolved into the double rose, the placing of identical cuts back to back.

In spite of the fact that the "pavilion" angles of the double rose are low, these stones are very brilliant. This is the result of no table, with light being gathered from many directions. The apex of a rose cut does not wear well, and thus is not good for ring settings. Double roses are excellent for earrings and pendants.

The Dutch rose is a very simple cut that may be varied in many ways. It may be cut either six or ten-fold, with subsequent changes in break facet angles; or facet rows may be added to deepen the stone. If this cut is made into a double rose, the girdle should be polished the same as for the standard brilliant.

The double Dutch rose is an excellent high scintillation form of the rose cuts. The name is somewhat misleading for, in this case, the word double refers to the larger number of facets over that of the Dutch rose. When it is cut into the double form, it should be correctly called the double, double Dutch rose. The girdle of the doubled form should be polished as for the standard brilliant.

The cross rose works nicely as a six or eight-fold stone, but appears to be more popular as six-fold. The double cross rose is excellent, and the girdle is left unpolished until after the stone is turned.

The rose recoupée might be considered a multifacet rose cut. It offers the simplicity and ease of execution of all the usual rose cuts, but the greater number of settings used results in excellent scintillation. When the recoupée is cut as a double rose, the girdle is left unpolished until after turning.

The lack of a table gives the rose cuts a decided advantage in that internal flaws of a gem are effectively hidden by the brilliance of the material. Here is an excellent group of cuts to use for those rare materials that cannot be found in flawless rough. This same feature of a gem without a table is exploited by other cuts such as the jubilee cut shown in a later section.

A few other rose cuts are shown with some of the regular cuts as variations of them. All angles given with the rose cuts are without reference to the culet angle, and these may be varied to suit the needs of the faceter.

The preform for a rose cut is a flat, slightly rounded cone which will vary according to the type of stone planned.

Diagram 8, The Commercial Cut

The commercial cut is excellent for very small stones. It returns a

surprising amount of brilliance, in spite of its simplicity.

The preform should be of the standard brilliant type.

Diagrams 9 and 10, The Briolettes

The briolettes are variations of the round brilliant form, and in reality are a rose cut attached to a highly elongated form of the same pattern. The amount of elongation is, within certain limits, entirely up to the faceter, and the angles of the portion above the girdle may be varied greatly. The most pleasing forms lie between the following limits: The shortest should have the upper portion at least two and one-half times as tall as the lower portion; the tallest should have the upper portion not over six times the height of the lower portion.

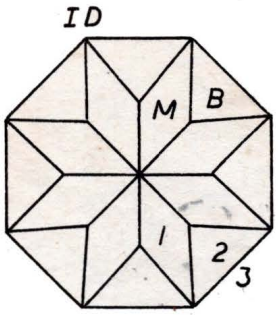
These are excellent cuts for use with medium to dark materials of a low refractive index. They have been used to advantage to show inclusions in clear materials. Recently the briolettes have been used effectively with opaque materials.

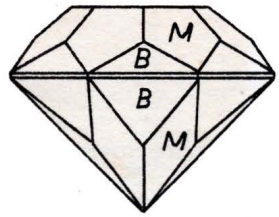
The brilliant briolette, Diagram 9, is a direct variation of the standard brilliant pavilion. The multifacet briolette, Diagram 10, is an adaptation of the simplified form of the double diamond cut. The step briolette, in a later section, is remarkably similar to the round step cut.

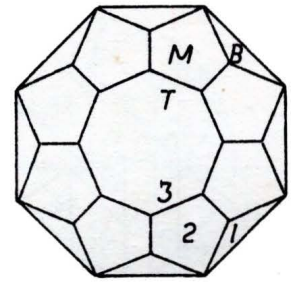
The preform for the briolette should be a long cone plus a very short cone, each with a pronounced curve.

PETAL CUT

(see page 105)







PAVILION- eight-fold symmetry, 32 index, using all asterisk (*) main, and all star settings.

1- cut eight main facets (M) at culet angle, on the eight-fold asterisk (*) main settings. These facets must meet at a point at the culet.

2- eight break facets (B) at culet angle plus 6°, on star settings midpoint of step 1 settings. These meet at the girdle, and overlap slightly.

3- eight girdle facets at 90°, on step 2 settings. The girdle must be a perfectly horizontal line.

Suggested polishing order; 1-2. Do not polish girdle.

CROWN- all facets are cut on the settings used on pavilion. Align stone by indexing any girdle facet to a star setting, and placing it flat to the polishing lap. Polish girdle.

1- eight break facets (B) at crown angle plus 18°, on the girdle alignment settings.

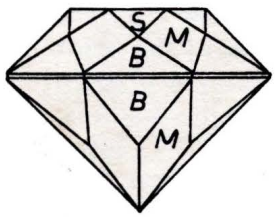
2- eight main facets (M) at crown angle, on settings midpoint of step 1 settings.

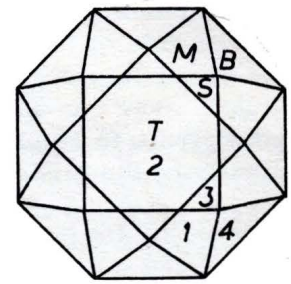
3- cut the table (T) at 0°, to where its width is 50% of the stone width.

Suggested polishing order; 3-2-1.

EIGHT-SIDED BRILLIANT

(see page 105)





PAVILION- identical to petal cut above.

CROWN- use the same settings as the pavilion. Use petal cut alignment.

1- cut eight main facets (M) at crown angle, on the eight-fold asterisk (*) settings. Leave ample girdle.

2- cut the table (T) at 0°, to where its width is 60% of the stone width.

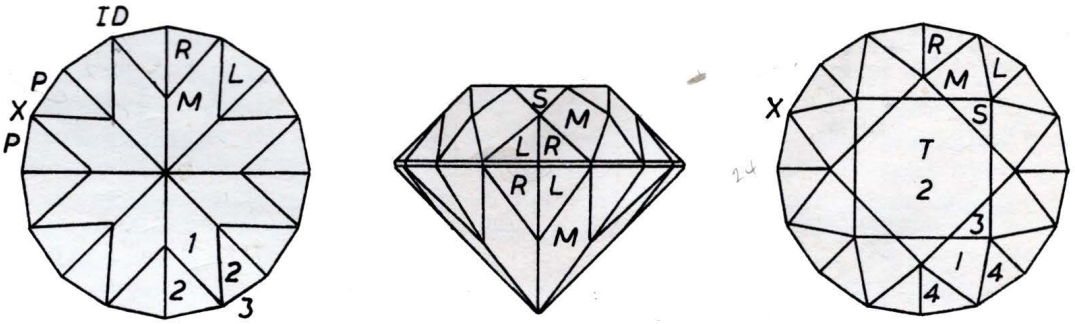
3- eight star facets (S) at crown angle less 15°, on star settings at midpoint of step 1 settings.

4- eight break facets (B) at crown angle plus 10° to 18°, on step 3 settings. The angle is found by trial.

Suggested polishing order; 2-3-1-4.

STANDARD BRILLIANT

(see page 105)



PAVILION- eight-fold symmetry, 32 index, using all main and break settings. For 64, 96, or 120 index see the eight-fold transposition chart.

1- cut eight main facets (M) at culet angle, on the asterisk (*) main settings of the eight-fold transposition chart.

2- sixteen break facets (R&L) at culet angle plus 2°. With the 32 index, the facets are placed one to each side of the step 1 settings. With the 64 index, skip one setting; with the 120 index, skip three settings to each side of the step 1 settings. The break facets should reach slightly over one-half of the way from girdle to culet, and overlap slightly at the girdle.

3- sixteen girdle facets at 90°, on step 2 settings. The main facets should now end in a point at the girdle, and the girdle should form a continuous unbroken line around the stone.

Suggested polishing order; 1-2, and one pair of girdle facets (P), one to each side of a main (X).

CROWN- 32 index, using all settings. For other eight-fold indexes, use the settings of the pavilion, plus the eight star settings. Align stone by indexing the point (X) to a main setting, and placing one of the polished girdle facets (P), flat to the polishing lap. The girdle facet is now aligned to a break setting. Polish the girdle.

1- cut the eight main facets (M) at crown angle, on the asterisk (*) main settings. Leave the correct amount of girdle at this step.

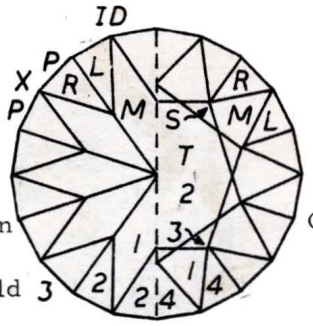
2- cut the table (T) at 0°, to where its width is about 60% of the width of the stone.

3- eight star facets (S) at crown angle less 15°, on star settings midpoint of those used in step 1. The stars must meet around the table.

4- sixteen break facets (R&L) at crown angle plus 3° to 8°, on the settings used for the girdle. Each break must touch the star facet and pinch off the main to a point at the girdle.

Suggested polishing order; 2-3-1-4.

VARIATIONS OF THE STANDARD BRILLIANT



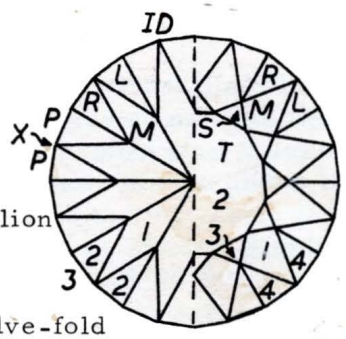
Pavilion Crown

Ten-fold

(see page 106)

PAVILION- 40 index, all main and break facets used. Cutting order is identical to the standard brilliant, except for multiples of ten instead of eight. Main angles are identical, break angles are slightly higher.

CROWN- all 40 index settings used. Main and star angles are identical, Break angles are slightly higher.

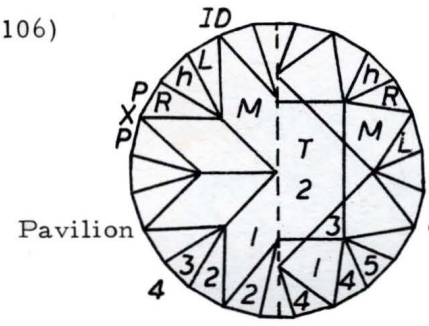


Pavilion Crown

Twelve-fold

PAVILION & CROWN- 48 index, using the same settings as the standard brilliant, except for multiples of twelve. Main and star angles remain the same, break angles are lower.

Polishing order for both variations is identical to the standard brilliant.



Pavilion Crown

THE HIGHLIGHT CUT

PAVILION- 32 index, use steps 1 & 2 for the standard brilliant.

3- cut eight break facets (h) on star settings midway of those of step 2, at culet angle plus nearly 3°. This facet divides the girdle, between two mains, exactly into thirds, and must touch the juncture of the mains.

4- twenty-four girdle facets at 90°, on step 2 & 3 settings.

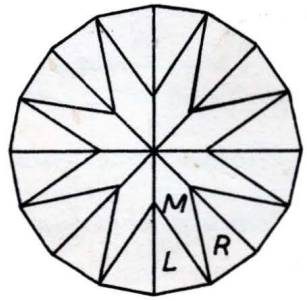
Suggested polishing order; 1-2-3, and two R & L girdle facets (P), one on each side of a main facet (X).

CROWN- align stone by placing a polished girdle facet (P), on a break setting, flat to the polishing lap. Polish girdle.

1-2-3-4- as for the standard brilliant.

5- eight break facets (h) at culet angle plus 6° to 10°, on step 3 settings. This facet must touch the star and match the girdle facet beneath.

Suggested polishing order; 2-3-1-4-5.

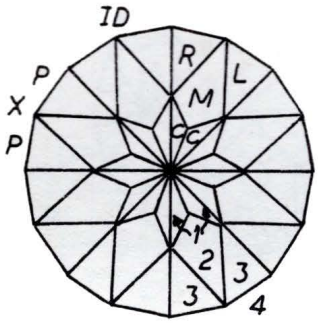


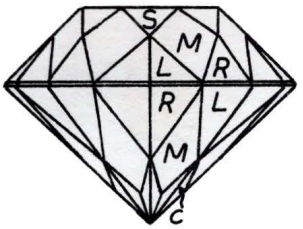
THE DIAMOND CUT

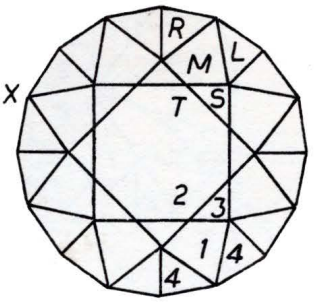
This cut is done by extending the pavilion breaks past midpoint. The break angle is slightly less than 2° above the culet angle. The crown is not altered.

ZIRCON CUT

(see page 106)







PAVILION- eight-fold symmetry, 32 index, using all main and break settings. For 64, 96, or 120 index, see the eight-fold transposition chart.

1- establish the settings on which the main facets of step 2 are to be cut. These are the eight-fold asterisk (*) main settings. Cut sixteen culet facets (C) at the culet angle, on break settings adjacent to the settings to be used in step 2. With 64 index, skip 1 setting; with 96 index, skip two settings; and with 120 index, skip three settings on each side of the main setting.

2- eight main facets (M) at culet angle plus 6°. These should reach the girdle area, and pinch off the culet facets midway to the culet.

3- sixteen break facets (R& L) at culet angle plus 10° to 12°, on step 1 settings. The breaks must touch the tips of the culet facets.

4- sixteen girdle facets at 90°, on step 3 settings.

Suggested polishing order; 1-2-3, and one pair of girdle facets (P), one to each side of a main (X).

CROWN- 32 index, using all settings. For other eight-fold indexes, use the settings of the pavilion, plus eight star settings. Align stone by indexing the point (X) to a main setting, and placing one of the polished girdle facets (P), flat to the polishing lap. The girdle facet is now aligned to a break setting. Polish the girdle.

1- cut the eight main facets (M) at crown angle, on the asterisk (*) main settings. Leave the correct amount of girdle at this step.

2- cut the table (T) at 0°, to where its width is about 60% of the width of the stone.

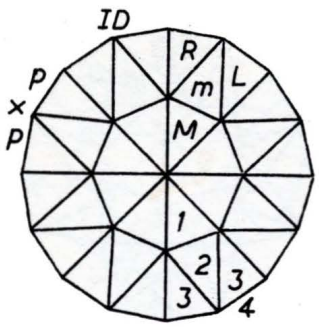
3- eight star facets (S) at crown angle less 15°, on star settings midpoint of those used in step 1. The stars must meet around the table.

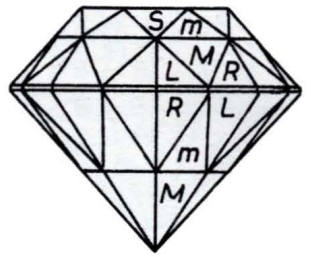
4- sixteen break facets (R& L) at crown angle plus 3° to 8°, on the settings used for the girdle. Each break must touch the star facet and pinch off the main to a point at the girdle.

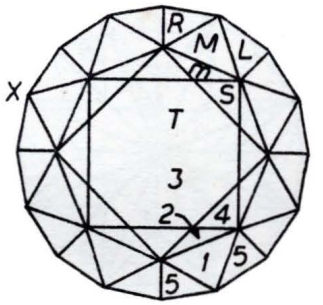
Suggested polishing order; 2-3-1-4.

HORIZONTAL SPLIT MAINS BRILLIANT

(see page 106)







PAVILION- eight-fold symmetry, 32 index, using all main and break settings. For 64, 96, or 120 index see the eight-fold transposition chart.

1- cut eight main facets (M) at culet angle, on the eight-fold asterisk (*) main settings. These mains need extend only halfway to the girdle area.

2- eight secondary main facets (m) at culet angle plus 5°, on step 1 settings. The secondary mains should meet the mains (M) at mid-point from culet to girdle.

3- sixteen break facets (R&L) at culet angle plus 7° to 9°. With 32 index, the break facets are placed on break settings, one on each side of step 2 settings. With 64 index, skip one setting; with 96 index, skip two settings; and with 120 index, skip three settings to each side of step 2 settings. The breaks should touch the junction of the mains (M&m), and overlap slightly at the girdle.

4- sixteen girdle facets at 90° on the settings used in step 3.

Suggested polishing order; 1-2-3, and one pair of girdle facets (P), one to each side of a main (X).

CROWN- 32 index, using all settings. For other eight-fold indexes, use the settings used on the pavilion, plus the star settings of step 4. Align stone by indexing the point (X) to a main setting, and placing one of the polished girdle facets (P), flat to the polishing lap. The girdle facet is now aligned to a break setting. Polish the girdle.

1- cut eight main facets (M) at crown angle, on the eight-fold asterisk (*) main settings. Leave the correct girdle height at this step.

2- eight secondary main facets (m) at crown angle less 7°, on step 1 settings. These should meet mains (M) about one-third of the way from table area to girdle.

3- cut the table (T) at 0°, to where its width is about 60% of the stone width.

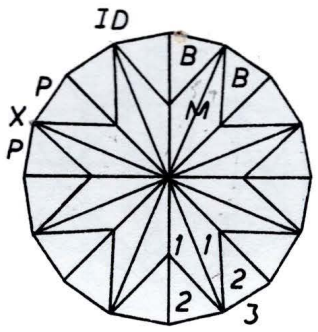
4- eight star facets (S) at crown angle less 14° to 20°, on star settings midpoint of those of step 2. The stars meet around the table, and touch the junction of main facets (M&m).

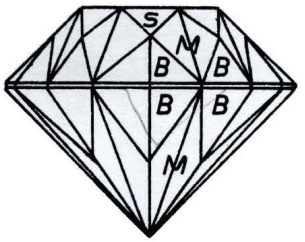
5- sixteen break facets (R&L) at crown angle plus 3° to 8°, on the settings used for the girdle. These reach from stars to girdle.

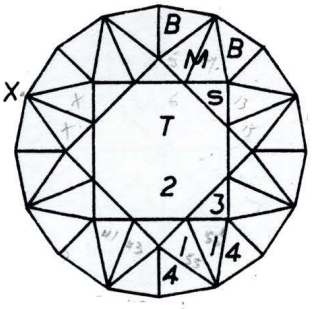
Suggested polishing order; 3-4-2-1-5.

VERTICAL SPLIT MAINS BRILLIANT

(see page 106)







PAVILION- eight -fold symmetry, 64 index, using star and break settings.

PAVILION- eight-fold symmetry, 64 index, using star and break settings. The "main" facets are split, and are cut on break settings, with the break facets cut on star settings. The 96 or 120 index will not satisfactorily produce this cut.

1- eight split main facets (M) at culet angle, on sixteen break settings, one to each side of the eight-fold asterisk (*) main settings. Cut two facets, one to each side of the main setting, then move to the next asterisk main for the next pair.

2- sixteen break facets (B) at culet angle plus 2°, on all star settings. These star settings lie midpoint of all 64 index main settings. See the eight-fold transposition chart.

3- sixteen girdle facets at 90° on step 2 settings.

Suggested polishing order; 1-2, and two girdle facets (P), one to each side of a "main" (X).

CROWN- 64 index, using all settings of the pavilion, plus eight (non-asterisk) main settings for the star facets. Align stone by indexing the point (X) to a main setting, and placing one of the polished girdle facets (P), flat to the polishing lap. The girdle facet is now aligned to the correct break setting. Polish the girdle facets.

1- eight split main facets (M) at crown angle. These are duplicates of the settings of pavilion step 1.

2- cut the table (T) at 0°, to where its width is 60% of the stone width.

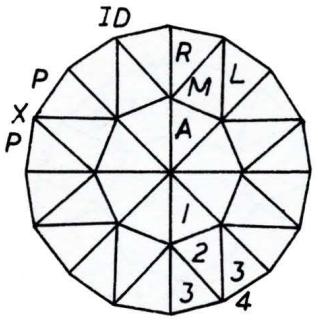
3- eight star facets (S) at crown angle less 15°, on alternate main settings. These are the non-asterisk mains of the 64 index, and lie midpoint of the main settings used for the split mains.

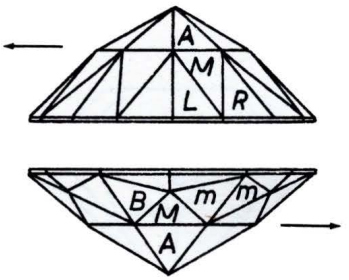
4- sixteen break facets (B) at crown angle plus 3° to 9°, on the settings used to polish the girdle.

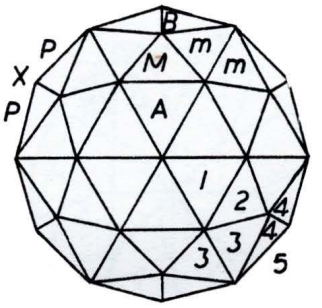
Suggested polishing order; 2-3-1-4.

THE ROSE CUTS

(see page 107)







Dutch Rose

Eight-fold symmetry- 32 index, using all main and break settings.

1- cut eight apex facets (A) at 30°, on eight-fold asterisk (*) main settings.

2- eight main facets (M) at 35°, on step 1 settings.

3-4- sixteen break facets (R&L) at 46° to 50°, and sixteen girdle facets at 90°, on break settings adjacent to step 2.

All rose polishing orders; same as cut.

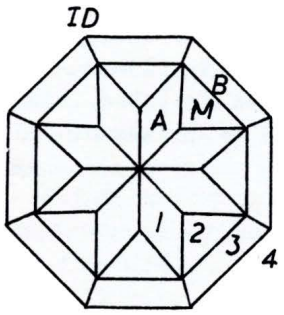
Double Dutch Rose

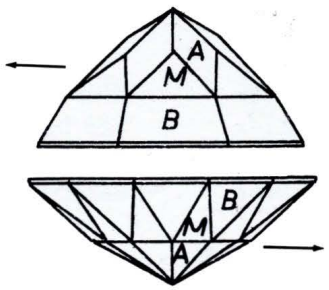
Six-fold symmetry- 48 index, using all break and alternate main settings.

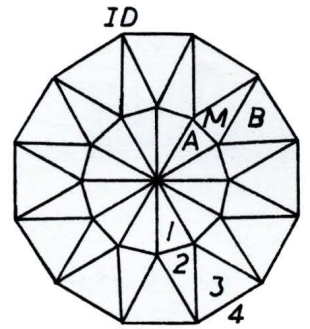
1-2- six apex facets (A) at 30°, and six main facets (M) at 35°, on six-fold asterisk (*) settings.

3- twelve vertical split mains (m) at 50°, on break settings adjacent to the unused mains of step 1 and 2.

4-5- twelve break facets (B) at 52° to 60°, and twelve girdle facets at 90°, on break settings adjacent to step 2.







Cross Rose

Eight-fold symmetry- 32 index, using all main and star settings.

1- cut eight apex facets (A) at 30°, on eight-fold asterisk (*) settings.

2-3- eight main facets (M) at 35°, and eight break facets (B) at 40°, on star settings midpoint of step 1.

4- eight girdle facets at 90°, on step 3 settings.

Rose Recoupée

Twelve-fold symmetry- 48 index, using all main and star settings.

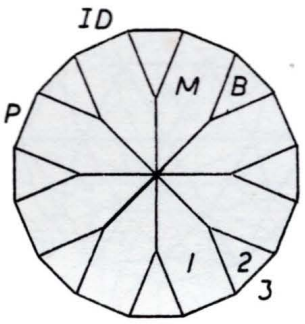
1- cut twelve apex facets (A) at 30°, on all asterisk (*) main settings.

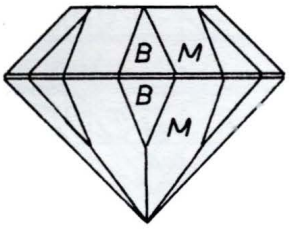
2- twelve main facets (M) at 45°, on step 1 settings.

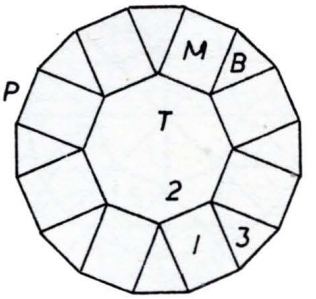
3-4- twelve break facets (B) at 47° to 50°, and twelve girdle facets at 90°, on star settings midpoint of step 2 settings.

COMMERCIAL CUT

(see page 107)







PAVILION- eight-fold symmetry, 32 index, using all main and star settings. For larger indexes, see the eight-fold transposition chart.

1- eight main facets (M) at culet angle, on eight-fold asterisk (*) settings.

2- eight break facets (B) at culet angle plus 2^{o}, on star settings midpoint of step 1 settings. These extend halfway from culet to girdle.

3- sixteen girdle facets at 90^{o}, on step 1 and 2 settings. Each girdle facet must be the same width.

Suggested polishing order; 1-2, and any step 1 setting girdle facet (P).

CROWN- all facets cut on the same settings used for the pavilion. Align stone by indexing the polished girdle facet (P) to a main setting, and placing it flat to the polishing lap. Polish the girdle facets.

1- eight main facets (M) at crown angle.

2- cut the table (T) at 0^{o}, to where its width is 60% of the width of the stone.

3- eight break facets (B) at crown angle plus 1^{o} to 4^{o}, at midpoint of step 1 main settings. The break ends in a point at the table, and its base is as wide as the girdle facet.

Suggested polishing order; 2-1-3.

THE COMMERCIAL ROSE

The pavilion of the commercial cut may be adapted to a rose cut (see diagram 7), by splitting the main facets, and using the angles below.

1- eight apex facets at 30^{o} on main settings. These are the inner half of the main facets (M) above, and should extend halfway from culet to girdle.

2- eight accessory mains (the second portion of facet M), at 40^{o}, on step 1 settings. These should be cut until both portions are equal in length.

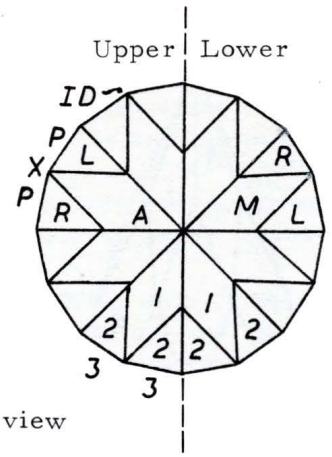
3- eight break facets at about 42^{o}, on settings midpoint of those of step 2. These should extend to the junction of step 1 and 2 facets.

4- sixteen girdle facets at 90^{o}, on step 2 and 3 settings.

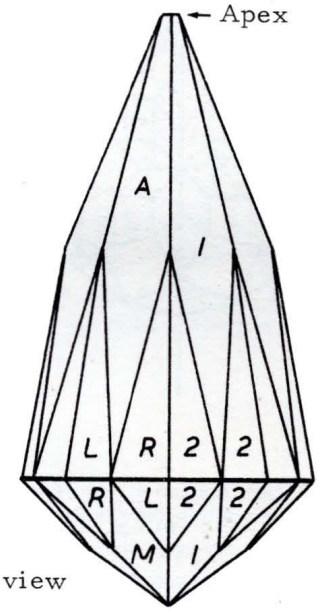
Suggested polishing order; 1-2-3-4.

BRILLIANT BRIOLETTE

(see page 108)



Axis view



Side view

UPPER PORTION - eight-fold symmetry, 32 index, using all main and break settings.

1- cut eight main facets (M) at 65°, on eight-fold asterisk (*) main settings. These reach from the girdle area to the apex. If possible leave a small uncut area (part of the preform) at the apex. It will be difficult to place it later. This flat apex will reduce the possibility of chipping after the gem is finished.

2- sixteen break facets (L&R) at 68° to 72°, on break settings adjacent to step 1 mains. These should extend halfway from girdle to apex.

3- sixteen girdle facets at 90°, on step 2 settings.

Suggested polishing order; 1-2, and two step 3 girdle facets (P), one on each side of a main (X).

LOWER PORTION - 32 index, using the same settings as for the upper portion. Align stone by indexing one of the polished girdle facets (P), to the proper break setting, and placing it flat to the polishing lap. Polish the girdle.

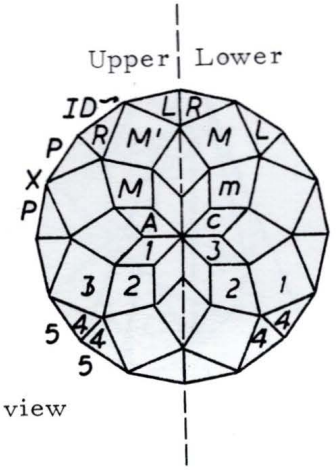
1- cut eight main facets (M) at 40°, on the eight-fold asterisk (*) main settings. These must extend from culet to girdle. The angle may be adjusted if necessary.

2- sixteen break facets (L&R) at 42° to 46°, on break settings adjacent to the step 1 mains.

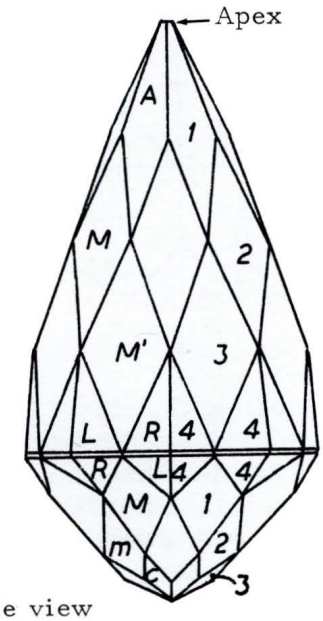
Suggested polishing order; 1-2.

MULTIFACET BRIOLETTE

(see page 108)



Axis view



Side view

UPPER PORTION- eight-fold symmetry, 32 index, using all settings.

1- cut eight apex facets (A) at 55°, on eight-fold asterisk (*) main settings. These should extend about halfway from the apex to the girdle area. Leave the flat apex as in step 1 of diagram 9.

2- eight central main facets (M) at 65°, on star settings midway between step 1 settings.

3- eight main facets (M') at 75°, on step 1 settings. These must touch the girdle area, and touch the lower tip of step 1 facets.

4- sixteen break facets (L&R) at 82° to 87°, on break settings midpoint between step 2 and 3 settings. These must touch the lower tips of step 2 mains, and meet adjacent break facets at the base of step 3 mains.

5- sixteen girdle facets at 90°, on step 4 settings. These should touch the lower points of step 3 mains.

Suggested polishing order; 1-2-3-4, and two step 5 girdle facets (P), one on each side of a step 3 main (X).

LOWER PORTION- all facets are cut on the settings of the upper portion. Align stone by indexing one of the polished girdle facets (P), to the proper break setting, and placing it flat to the polishing lap. Polish the girdle facets.

1- cut eight main facets (M) at 60°, on the eight-fold asterisk (*) settings.

2- eight accessory mains (m) at 40°, on star settings midpoint between step 1 settings.

3- eight culet facets (c) at 25°, on step 1 settings.

4- sixteen break facets (L&R) at 65° to 75°, on break settings midpoint between step 1 and 2 mains. The breaks should reduce the girdle to a thin band, and also touch the tips of step 2 mains.

Suggested polishing order; 3-2-1-4.

All angles may be changed to suit any reasonably shaped preform.

SECTION II

Diagrams 11 to 14 -- Brilliants, Variations Of A Circle

These variations are usually difficult to cut. The easiest are the ovals, with the pendeloque and the marquise being more difficult. Each of these, and other related cuts, call for a refined technique and frequent careful use of the cheater. They have been characterized by some as the "cut and inspect group". Constant inspection is in order to correctly execute one of this group.

In all of these cuts certain facets in each row will cut at different angles than those in the same row, but in a different portion of the stone. This change in angle will follow a certain sequence, and the difficulty is not as great as it may appear. Each cut will produce an excellent gem. None of this group should be used with materials of strong pleochroism.

Diagrams 11 and 12, The Brilliant Ovals

The ovals are derived from the round brilliants, but no faceter should attempt to cut one until he thoroughly understands the cutting of the round brilliant. They are difficult to do because the slightest difference in the curve of the outline forces changes in the angles of most of the facets. Most ovals preformed at random are different from each other, thus there seldom would be two ovals that would cut at even near the same angles.

The angular differences between adjacent facets on the same row varies according to the length to width ratio of the oval. The narrow oval of about twice the length as width (the 30° oval) has the greater angular differences. The wider oval having the length about one and one-half times the width (the 45° oval) calls for lesser angular differences. (The only situation where one does not find angular differences is with a perfect circle.) It is possible to cut an oval as narrow as three to one (15°) and as wide as one and one-fourth to one (60°), but these extremes in shape are not pleasing.

The ovals used here as cutting diagrams have the one and one-half to one proportions. These are the most pleasing, but variations to either side are satisfactory. The diagrams here are of twelve-fold symmetry, which is the easiest to do. Ovals of sixteen-fold symmetry are also easy to do, but unless the stone is large it may appear to be overdone. Eight-fold symmetry ovals are possible, but very difficult to accomplish as there are too few main facets (and related facets of the symmetry unit) to correctly negotiate the curve.

The oval with the culet as a point is possibly a bit easier to cut than is the oval with the culet as a line. It has the advantage that each set of culet facets is at a different angle, with only a slight angle change needed to bring a facet to where it is desired. In this type of oval the main facets are nearly of equal width, and the scintillation from them gives the whole stone nearly equal brilliance. This, however, produces a very deep stone that offers difficulties when being set into jewelry. It also calls for a proportionately large piece of rough.

The oval with the culet as a line, Diagram 11, is probably the most satisfactory in that the stone is relatively shallow, and thus much easier to set into a commercial jewelry mounting. It also is saving of rough material over that of the type shown in Diagram 12. The wide center main facets offer a lowered scintillation which may give the stone a dead look in the center. This is a

deficiency of all elongated circles in faceted gems, but this type oval shows it greater than most others. At the same time, the end mains tend to become very narrow. This is the result of all pavilion mains being the same length.

The crown of either type of oval is identical, and when cutting Diagram 12 use Diagram 11 crown. The right side of Diagram 12 shows an oval with the main facets offset away from the end of the stone. It is readily seen that this has no effect on the shape of the stone, but may have an effect on the light behavior because of the reduction of the size of the side facets and the enlarging of the end facets.

The oval preform will depend upon the requirements of the final shape, but the area of the longest facets of the pavilion should be ground at least one degree above the culet angle for the material.

Diagram 13, The Pendeloque

The pendeloque is a difficult cut to execute, but the excellence of the gem is well worth the effort. It is admirably suited to odd-shaped pieces of rough; the stone displays well, and makes an excellent gem for a pendant.

The pendeloque is best suited to colorless and very light colored materials. The darker hues produce a stone with an annoying light band through the center. Medium to high R.I. materials are the best choice for the pendeloque.

The preform is somewhat of a combination of the marquise and the round brilliant, with care being taken that the slope of the pavilion from the point to the culet is above the culet angle for the material involved.

Diagram 14, The Marquise

The marquise cut makes an interesting gem that is excellent for use in a dinner ring or brooch. The cut is best used with colorless or very light colored gem material. Medium to dark hued stones show the lack of central scintillation inherent to this group. Marquise gems also have the undesirable feature of the two sharp ends that chip easily.

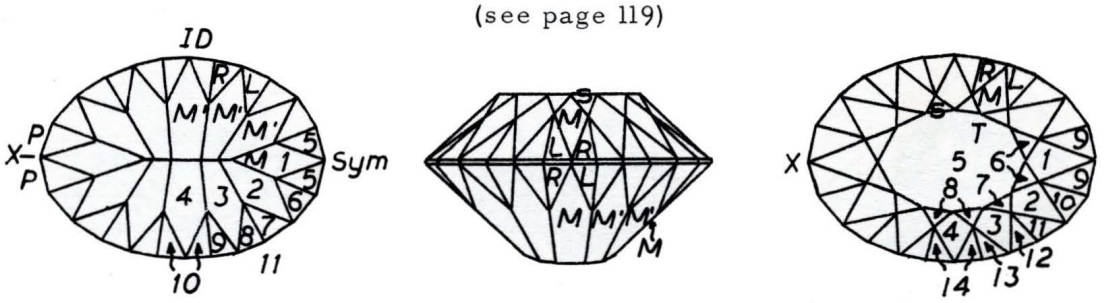
This cut has some intriguing design limitations. As the sides of the stone are segments of a true circle, the radii of the sides control the shape of the gem. The narrowest stone for pleasing balance and cutting ease has a radius equal to the length of the stone, and has a length about three times the width. The widest stone based upon the same criteria has a radius of one and one-fifth the width, and a length twice the width. The cutting directions given here are for a stone with length twice the width.

Certain facets may not cut on the settings given, such as the break facets to either side of the end mains (step 4 pavilion). These may cut on star settings, or on main settings (the missing mains), depending upon the shape of the stone. Regardless of substitutions, marquise gems of reasonable proportions are excellent.

The preform must conform to the shape of the desired finished gem, with special care taken that the area between points and the culet are above the culet angle for the material.

OVAL WITH CULET AS A LINE

(see page 119)



PAVILION- twelve-fold symmetry, 48 index, using all main, and all break settings. For 96 or 120 index, see six-fold transposition chart.

1- cut two end main facets (M) at culet angle, on symmetry (Sym) setting and its opposite.

2-3-4- cut the balance of the main facets (M') at culet angle. This will create the knife-edge culet between the end mains. All mains will be the same length, but their widths will increase toward the side mains. The end mains will be quite narrow in relation to the wide side mains.

5- two pair of break facets adjacent to the end mains, at culet angle plus 2°, on break settings adjacent to step 1 settings. These reach midway on the end main.

6-7-8-9-10- cut the remaining breaks, on break settings adjacent to step 2, 3, and 4 settings. These are quadruples with a common angle. The angle will be from 2° to 8° greater than the culet angle. There should be an angular increase from one group of four to the next, and it will depend upon the shape of the oval. Any increase between groups will be progressive and orderly.

11- twenty-four girdle facets at 90°, on step 5, 6, 7, 8, 9, and 10 settings.

Suggested polishing order; all mains, all breaks, and two girdle facets (P) adjacent to an end main facet.

CROWN- 48 index, using all settings. For 96 and 120 index, see the six-fold transposition chart. Align the stone by indexing one of the polished girdle facets (P) to the proper break setting and placing it flat to the polishing lap. The end of the stone (X) must be indexed to a main setting. Polish the girdle.

1-2-3-4- cut twelve main facets (M) at crown angle, in pairs and quadruples, beginning with the end mains. There might be a need for small angular increases as cutting moves toward the sides.

5- cut the table (T) at 0°, to where its width is about 60% of the stone width.

6-7-8- cut twelve star facets (s) at crown angle less 15°, in quadruples, beginning with the end pairs (6), on star settings midpoint of the main settings. Again, there might be need for small angular increases toward the sides.

9- two pair of end breaks at crown angle plus 3° to 8°.

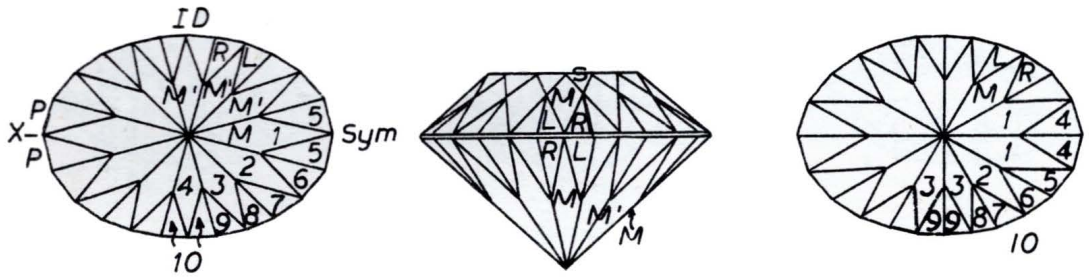
10-11-12-13-14- cut the remaining break facets in quadruples. The angle of group 10 will be slightly greater than 9; 11 will be greater than 10, etc.

Suggested polishing order; table, all stars, all mains, all breaks.

Diagram 12

OVAL WITH CULET AS A POINT

(see page 119)



PAVILION- twelve-fold symmetry, 48 index, using all main and break settings. For 96 or 120 index, see six-fold transposition chart.

1- cut the two end main facets (M) at culet angle, on symmetry (Sym) setting and its opposite.

2-3-4- cut the balance of the main facets (M') at culet angle plus 1° to 6°, on all main settings. The angle will increase as cutting moves toward the side mains. The increase will be large with a narrow oval, and and small with a wide oval.

5- two pair of break facets (R&L) at culet angle plus 2°, on break settings adjacent to step 1 settings.

6-7-8-9-10- cut the remaining breaks, on break settings adjacent to step 2, 3, and 4 settings. These are quadruples with a common angle. The angle will increase, for each group of four over that of the previous group, as cutting moves toward the sides of the stone. The increase will follow the pattern of steps 2 to 4, with the angle being 2° to 8° above the culet angle.

11- twenty-four girdle facets at 90°, on step 5, 6, 7, 8, 9, and 10 settings.

Suggested polishing order; all mains, all breaks. Polish two end girdle facets (P).

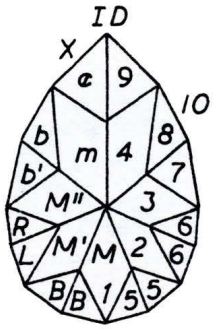
CROWN- the crown of this oval is identical to that of diagram 11, and is cut and polished accordingly.

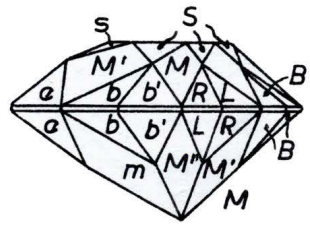
The pavilion above indicates an oval in which the main facets have been rotated to a star position. The cutting order for this variation is approximately the same as the other ovals, with the angles and angular differences only slightly different. The advantage of this facet arrangement is the possibility that it may tend to have smaller main facets at the sides, and larger mains at the ends.

The oval with the culet as a point has quite similarly shaped facets in each group, and within each group, they are reasonably symmetrical. The oval with the culet as a line has the pavilion main facets somewhat distorted with a decided lack of similarity of shape and symmetry. This situation is most apparent in the pavilion break facets. Any changes away from the 45° oval (used in these diagrams) will change this similarity and symmetry situation.

PENDELOQUE CUT

(see page 120)





PAVILION- eight-fold symmetry, 64 index, using seven of the eight-fold asterisk (*) settings, and some breaks and stars.

1- cut one main facet (M) at culet angle, on the asterisk (*) setting opposite the ID setting.

2-3-4- six main facets; (M') at culet angle plus 1°, (M'') at culet angle plus 3°, and (m) at culet angle plus 2°, on asterisk (*) settings between step 1 and 2 settings.

5- four break facets (B) at culet angle plus 3° to 5°, on star settings adjacent to step 1 and 2 settings.

6- four break facets (L&R) at culet angle plus 4° to 6°, on break settings adjacent to step 2 and 3 settings.

7- two break facets (b') at culet angle plus 8° to 10°, on star settings midpoint of step 3 and 4 settings.

8- two break facets (b) at culet angle plus 8° to 12°, on break settings adjacent to step 4 settings.

9- two break facets (e) at culet angle plus 3° to 6°, on main settings at midpoint of step 4 and ID settings.

10- fourteen girdle facets at 90°, on step 5 to 9 settings.

Suggested polishing order; 1 to 9 as cut, and a girdle facet (X), on a step 9 setting.

CROWN- 64 index, using the same main and break settings as for the pavilion, plus main and star settings for the star facets. Align stone by indexing the polished girdle facet (X), to a main setting adjacent to the ID setting, and placing it flat to the polishing lap. Polish the girdle.

1-2-3- cut five main facets (M) at crown angle, on the settings of pavilion steps 1, 2, and 3.

4- two main facets (M') at crown angle plus 2°, on the asterisk (*) settings adjacent to the ID setting.

5- cut the table (T) at 0°, to where its width is approximately 50% of the stone width.

6- six star facets (S) at crown angle less 15° to 20°, on main settings midpoint of steps 1 and 2, 2 and 3, 3 and 4.

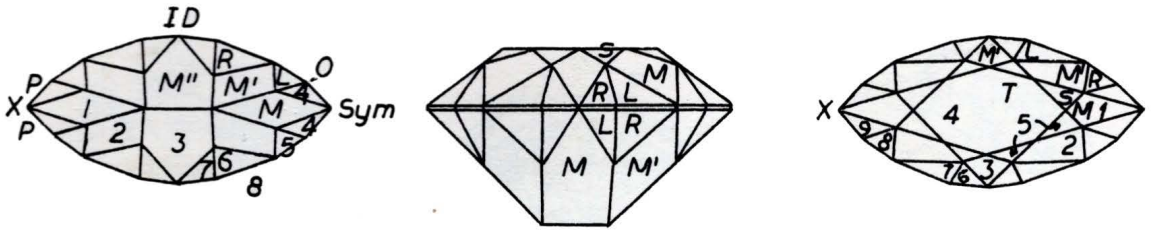
7- two star facets (s) at crown angle less 18° to 24°, on star settings adjacent to the ID setting.

8-9-10-11-12- fourteen break facets (B, L&R, b', b, & e) at crown angle less 5° to 15°, on the settings of step 5 through 9 of the pavilion. These must match the girdle facets.

Suggested polishing order; 5-6-7, 1 to 4 as cut, 8 to 12 as cut.

MARQUISE CUT

(see page 120)



PAVILION- eight-fold symmetry, 48 index, using eight of the twelve main settings, and break settings adjacent to them. For 96 or 120 index, see the six-fold transposition chart.

1- cut the two end main facets (M) at culet angle, on symmetry (Sym) setting and its opposite.

2- skip one main setting (O) to each side of the step 1 main, and cut four main facets (M') at culet angle plus 6° to 12°. For 96 index skip three mains, for 120 index skip four mains.

3- two side mains (M'') at culet angle plus 6° to 12°, on ID setting and its opposite. These will make a knife-edge culet between step 1 settings.

4- two break facets at culet angle plus 4° to 15°, on break settings adjacent to the end mains.

5-6-7- cut the balance of the break facets in quadruples at culet angle plus 8° to 20°, on break settings adjacent to step 2 and 3 settings. Step 5 angle will be the lowest, with a progressive rise toward the sides. Use the cheater to bring all breaks in place.

8- sixteen girdle facets at 90°, on step 4, 5, 6, and 7 settings.

Suggested polishing order; mains, breaks, and two end girdle facets (P).

CROWN- all facets are cut on the settings of the pavilion, plus four main and four star settings. Align stone by placing one of the polished girdle facets (P), flat to the polishing lap. The point (X) must be indexed to symmetry (Sym) setting and its opposite. Polish the balance of the girdle facets.

1- cut two end mains (M) at crown angle.

2-3- cut the balance of the mains (M') at crown angle plus 1° to 10°, on step 2 and 3 settings of the pavilion. The angle will rise toward the sides. Leave enough girdle height.

4- cut the table (T) at 0°, to where its width is about 60% of the stone width.

5- eight star facets (S) at crown angle less 10° to 17°. The end stars are cut on the main settings skipped in step 2. The side stars are cut on star settings midpoint of step 2 and 3. The end stars will cut at a lower angle than the side stars.

6-7-8-9- cut the break facets (L&R) in quadruples at crown angle plus 1° to 15°, on the settings used for the girdle. The breaks at the sides will be at the higher angle, with a progressive drop toward the ends.

Suggested polishing order; table, stars, mains, breaks.

SECTION III

Diagrams 15 to 20 -- Brilliants Other Than Round

This group is a hodge-podge of shapes, with the girdle outline being almost any geometric figure other than a circle or a rectangle. Included are the hexagon, pentagon, triangle, square or nearly square, and others.

Many of this group are easy to execute as long as a definite sequence of facet placement is followed. The fine effects of these cuts depend upon the placement of facets and their precise meeting with those adjacent to them. All of the cuts are good, some are startling with the unusual effects that the geometrical outline imparts.

Diagram 15, Diamond Shape

Even though this cut is not a variation on a circle, it has many of the characteristics of the "cut and inspect" group. The slightest change in proportions will make placement of some facets difficult, and their angles will need to be changed. Much use of the cheater will be necessary in any case. This cut should not be used with the darker colors as it will show the light central portion in contrast to the darker ends.

The directions given are for the 96 index. The 64 index will give a stone with more "bulge" to the sides. The 48 index will produce a gem far too wide.

The preform for the diamond shape must be made slightly larger than is intended for the final gem, with special care being paid to the angle between the point and the culet.

Diagram 16, Square Brilliant

This is a very effective cut, and not as complicated as it looks. As it is shallow, it works well with dark materials. Because of the small number of facets, it does not make a good gem in sizes much over 20 millimeters.

This cut will find its greatest use with medium hued materials of medium refractive index. It will be satisfactory with the low R.I. materials, but its use with high R.I. material could be a waste of rough.

Preforming to a square outline, with a 45^{o} pyramid for the pavilion, is the easiest. Keeping the same pavilion shape and preforming the girdle to the correct outline may save material.

Diagram 17, Maltese Cross

The Maltese cross is a delightfully brilliant and interesting cut. It offers some cutting difficulty in the perfect matching of the wing facets to adjoining facets. This is another cut especially advantageous with low R.I. materials of light to medium colors. The intriguing twinkling effect of this cut is lost in a dark colored gem. The best sizes are between five and fifteen millimeters in width.

The preform should have a pyramidal pavilion with a small curve. The crown should be a truncate pyramid.

Diagram 18, Brilliant Triangle

The crown of the brilliant triangle is a modification of the scissors cut (Diagram 36), but the acute angle at the corners gives far greater brilliance. The cut is excellent with medium R.I. material of light color hues, and in sizes from seven to fifteen millimeters.

The preform should be a triangular pyramid with a slight curve to the pavilion.

Diagram 19, Five and Six-rayed Stars

The five-rayed star is brilliant beyond expectations. This is due in part to the acute angle at the corners. To be effective, it must be cut on a five-fold index. Any other index will produce an asymmetrical star. The cut is satisfactory for light to medium colored material of low to medium R.I. High R.I. material would be wasted with this cut.

The preform should be a pentagon with a small curve in the pavilion.

The six-rayed star is handled the same as the five-rayed star. The only exceptions are the different index, with the attendant larger number of facets, and a few angle changes. The six-rayed star is not as spectacular in shape as the five-rayed star, but the larger number of facets gives more scintillation. The type of material to use with this cut is the same as for the five-rayed star.

The preform should be a true hexagon with the pavilion being pyramidal, slightly deepened, and with a slight curve.

Diagram 20, Modified Trophy Cut

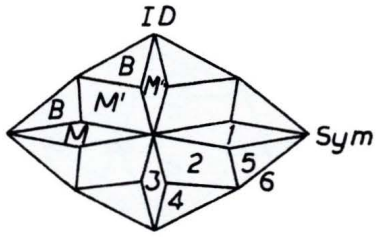
This is a simplified version of the cut that won the O'Brien Trophy in 1963. The cut was devised by Ed Porter of Burbank, California. Mr. Porter's complete directions for the cut were published in the January, 1964 issue of Gems and Minerals magazine.

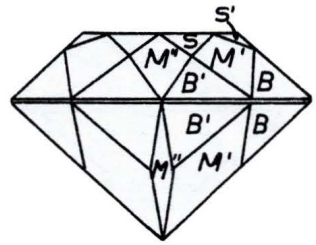
The original cut necessitated the use of a 96 index, whereas the simplified version here may be done with a 48 index. Both versions of the trophy cut are high in scintillation, and will work well with low to medium R.I. materials. Sizes up to twenty-five millimeters are satisfactory.

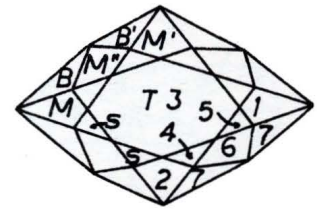
The preform for this cut should be a hexagon with the pavilion near the culet angle.

DIAMOND SHAPE CUT

(see page 125)







PAVILION- eight-fold symmetry, 96 index only, using the eight-fold asterisk (*) settings, and only eight break settings.

1- cut the two end main facets (M) at culet angle, on symmetry (Sym) setting and its opposite.

2- skip three main settings to each side of the step 1 mains for the four central mains (M'), at culet angle plus 10°.

3- two side main facets (M") at culet angle plus 12°, on ID setting and its opposite.

4- four break facets (B) at culet angle plus 14° to 18°, on break settings adjacent to step 2 mains. These lie between step 2 and 3 mains, pinch off step 3 mains at the girdle, and extend about halfway from girdle to culet.

5-four break facets (B') at culet angle plus 18° to 22°, on break settings adjacent to step 2 mains, but on the opposite side of those of step 4. It may be necessary to recut the step 2 mains after the breaks are in place. If so, this will need an angle change from step 2.

6- eight girdle facets at 90°, on step 4 and 5 settings.

Suggested polishing order; 1-2-3-4-5. Do not polish girdle.

CROWN- 96 index, using the same break and main settings of the pavilion, and eight star settings. Align stone by indexing one girdle facet to the correct break setting, and placing it flat to the polishing lap. Polish the eight girdle facets.

1- cut two end main facets (M) at crown angle less 10°.

2- two side mains (M') at crown angle.

3- cut the table at 0°, to a width of about 50% of the stone width.

4-four star facets (S) at crown angle less 12°, on star settings adjacent to the ID setting.

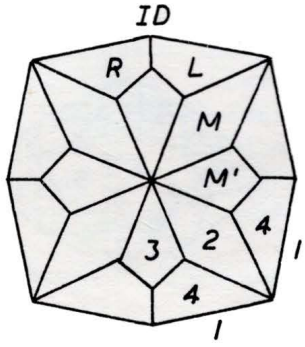
5- four star facets (S') at crown angle less 20°, on star settings adjacent to symmetry (Sym) setting.

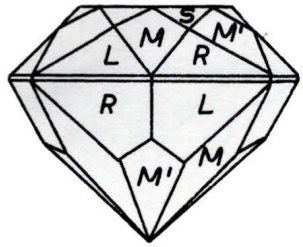
6- four central main facets (M") at crown angle plus 16° to 22°, skipping the same settings as in step 2 of pavilion.

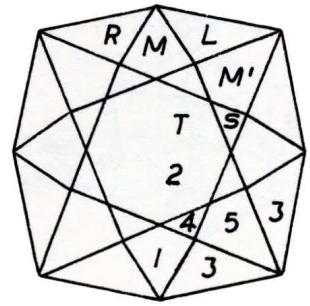
7- eight break facets (B) at crown angle plus 18° to 25°, on break settings used to polish the girdle. These should pinch off the main facets at the girdle, and touch the lower tips of the star facets. They may also cut away step 6 mains (M") and if so, the main should be recut.

Suggested polishing order; 3-4-5-1-6-2-7-8.

(see page 125)







PAVILION- eight-fold symmetry, 32 index, using all main and alternate break settings. For 64, 96, or 120 index, see the eight-fold transposition chart. Align preform, if square, with a side to a main setting; if to final shape, use the correct break setting.

1- establish the settings (alternate eight-fold asterisk *) to be used for the mains (M') in step 3. Cut the eight girdle facets on break settings, one to each side of step 3 mains. The girdle must be in the same plane completely around the stone.

2- four corner mains (M) at culet angle, on asterisk main settings midpoint of step 3 settings. These must reach from culet to girdle.

3- four side main facets (M') at culet angle, on settings established above. The side mains must reach the culet, but need not reach the girdle.

4- eight break facets (R& L) at culet angle plus 14°, on step 1 settings. The breaks must meet the base of the main (M) at the corner, and overlap on the sides, above the side main (M').

Suggested polishing order; 2-3-4. Do not polish girdle.

CROWN- 32 index, using all main and star settings, and alternate break settings. For 64, 96, or 120 index, see eight-fold transposition chart. Align stone by indexing one of the girdle facets to the correct break setting, and placing it flat to the polishing lap. Polish the girdle.

1- cut four side main facets (M) at crown angle. These will determine girdle height.

2- cut the table (T) at 0°, to where its width is 60% of the stone width.

3- eight break facets (R& L) at crown angle plus 6° to 12°, on break settings used to polish girdle. The break facets must reach the table, and bring the side mains (M) to a point at the girdle.

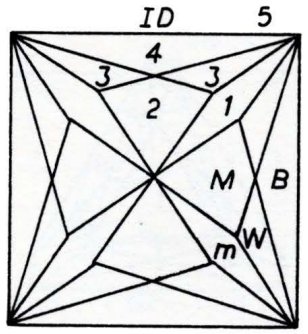
4- eight star facets (s) at crown angle less 15°, on star settings midpoint between the asterisk main settings. The stars meet above the side mains (M) and overlap at the corners. It is best to cut the stars as pairs at the side main.

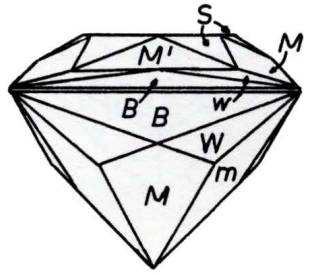
5- four corner mains (M') at crown angle less 6° to 12°. These must reach from table to girdle.

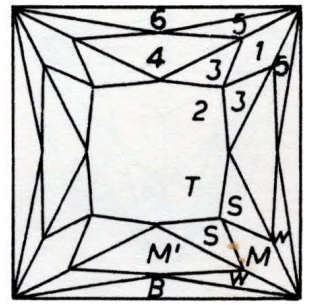
Suggested polishing order; 2-4-1-5-3.

MALTESE CROSS CUT

(see page 125)







PAVILION- four-fold symmetry, 64 index, using all asterisk main and alternate sets of break settings. For 96 or 120 index, see the eight-fold transposition chart.

1- cut the four corner main facets (m) at culet angle, on alternate eight-fold asterisk main settings. These facets must touch the girdle area.

2- four side main facets (M) at culet angle plus 5°, on the balance of the asterisk settings. These facets need not reach the girdle area.

3- eight wing facets (W) at culet angle plus 11°, on break settings adjacent to step 2 settings. The wings must touch the corners, and overlap in the center of the sides.

4- four break facets (B) at culet angle plus 18° to 25°, on step 2 settings. These erase part of the wing facets.

5- four girdle facets at 90°, on step 4 settings. The girdle facets close the pavilion at the corners.

Suggested polishing order; 2-1-3-4. Do not polish girdle.

CROWN- all facets are cut on the same settings as the pavilion. Align stone by indexing any girdle facet to a main setting, and placing it flat to the polishing lap. Polish the girdle.

1- cut four corner main facets (M) at crown angle less 12°.

2- cut the table (T) at 0°, to where its width is 60% of the stone width.

3- eight star facets (S) at crown angle less 17°, on break settings adjacent to step 1 settings. The stars meet at the sides of the table, pinch off the step 1 mains at the corners, and end about two-thirds of the way down the corner mains.

4- four side main facets (M') at crown angle less 12°, on main settings midpoint of those of step 1. These must touch the table between the stars.

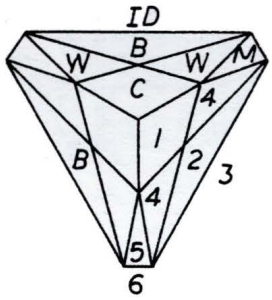
5- eight wing facets (w) at crown angle plus 3° to 8°, on step 3 settings.

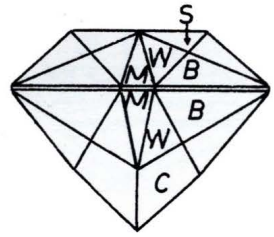
6- four break facets (B) at crown angle plus 18° to 30°, on step 4 settings. These bring the wings to a point at the center of the sides.

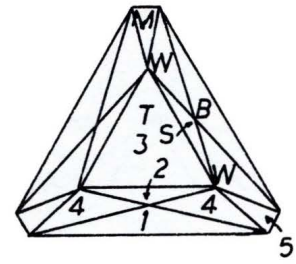
Suggested polishing order; 2-3-4-1-5-6.

TRIANGULAR BRILLIANT

(see page 126)







PAVILION- three-fold symmetry, 48 index, using six-fold asterisk main settings, and three pairs of break settings. For 96 or 120 index, see the six-fold transposition chart.

1- three culet facets (C) at culet angle on alternate six-fold asterisk main settings.

2- three break facets (B) at culet angle plus 22°, on step 1 settings.

3- three girdle facets at 90°, on step 2 settings. These will determine stone size.

4- six wing facets (W) at culet angle plus 5° to 15°, on break settings adjacent to step 2 settings. The wings meet across the long sides, above the break facets, and join at the corners to pinch off the culet facets about halfway from culet to girdle.

5- three corner main facets (M) at culet angle plus 4° to 10°, on the balance of the asterisk main settings. These facets must end in a point at the junction of facets (C& W) and pinch off facets (W& B) at the girdle.

6- three girdle facets at 90°, on step 5 settings.

Suggested polishing order; 1-2-3-4-5. Do not polish girdle.

CROWN- 48 index, using the same settings as for the pavilion. Align stone by indexing any long girdle facet to a main setting, and placing it flat to the polishing lap. Polish the girdle.

1- three break facets (B) at crown angle, on the alternate asterisk settings of pavilion step 1.

2- three star facets (S) at crown angle less 20°, on step 1 settings. These should meet the step 1 breaks about halfway from table to girdle.

3- cut the table at 0°, to where its width is approximately 50% of the stone width. The table should cut the stars to about one-third the height of the break facets.

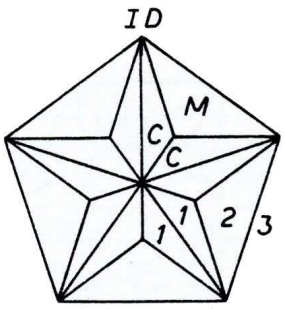
4- six wing facets (W) at crown angle less 10° to 15°, on break settings adjacent to the step 1 settings. The wings meet across the long sides, above the breaks, and pinch off the stars at the table corners.

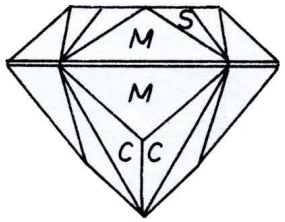
5- three corner mains (M) at crown angle less 15° to 20°, on the balance of the asterisk main settings. These mains end at a point at the table, and pinch off the wings and breaks at the girdle.

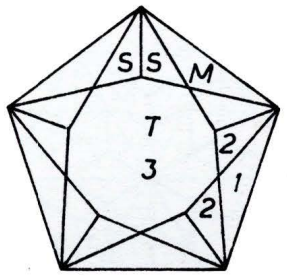
Suggested polishing order; 3-2-4-1-5.

FIVE AND SIX-RAYED STARS

(see page 126)







PAVILION- five-fold symmetry, 40 index, using non-asterisk main settings, and all star settings. For 80 or 120 index, see five-fold transposition chart.

1- cut ten culet facets (C) at culet angle, on all star settings.

2- five main facets (M) at culet angle plus 9°, on main settings midpoint between the asterisk main settings.

3- five girdle facets at 90°, on step 2 settings.

Suggested polishing order; 1-2. Do not polish girdle.

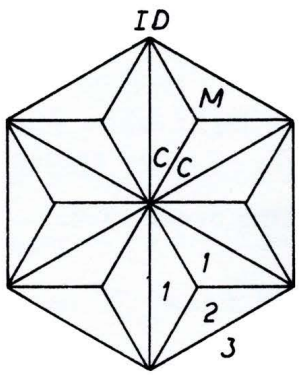
CROWN- all facets are cut on the settings used on the pavilion. Align stone by indexing any girdle facet to a main setting and placing it flat to the polishing lap. Polish the girdle.

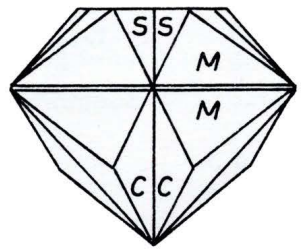
1- cut five main facets (M) at crown angle, using the girdle settings.

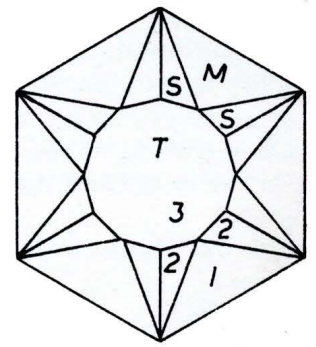
2- ten star facets (S) at crown angle less 10°, on all star settings. These touch the girdle at the corners.

3- cut the table (T) at 0°, to where it touches the juncture of the main and star facets.

Suggested polishing order; 3-2-1.







Six-fold symmetry, 48 index, using non-asterisk mains, and all star settings. For 96 or 120 index, see the six-fold transposition chart.

The six-rayed star cutting sequence is identical tc the five-rayed star. The above directions may be used with the following exceptions.

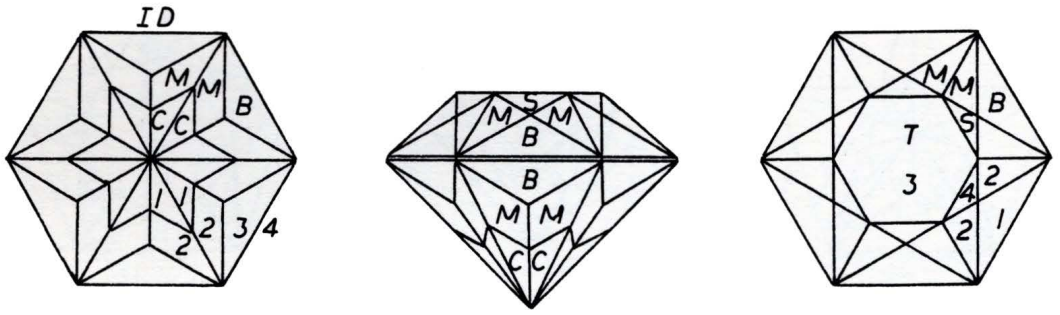
Always make a substitution of six facets for five, and twelve for ten. In pavilion step 2, the angle is culet angle plus 10°. In crown step 2, the angle is crown angle less 8°.

The polishing orders and the method of aligning are identical to that of the five-rayed star.

Diagram 20

MODIFIED TROPHY CUT

(see page 126)



PAVILION- six-fold symmetry, 48 index, using all six-fold asterisk main settings, and all break settings.

1- cut twelve culet facets (C) at culet angle, on break settings adjacent to the non-asterisk main settings.

2- twelve main facets (M) at culet angle plus 4°, on break settings adjacent to the asterisk main settings. The breaks to the right of the mains will need cheat to the left, and those to the left of the mains will need cheat to the right; in order to create the diagonal line between the culet and main facets.

3- six break facets (B) at culet angle plus 10° to 15°, on the asterisk main settings. Vary the angle to match the slant of the junction between the culet and main facets.

4- six girdle facets at 90°, on step 3 settings.

Suggested polishing order; 1-2-3. Do not polish the girdle.

CROWN- 48 index, using the same settings as for the pavilion. Align stone by placing any girdle facet, indexed to an asterisk setting, flat to the polishing lap. Polish the girdle.

1- cut six break facets (B) at crown angle plus 8°, on the asterisk main settings.

2- twelve main facets (M) at crown angle less 12°, on break settings adjacent to the non-asterisk main settings.

3- cut the table (T) at 0°, to where its width is about 60% of the stone width.

4- six star facets (S) at crown angle less 22° to 28°, on step 1 settings.

Suggested polishing order; 3-4-2-1.

SECTION IV

Diagrams 21 to 25 -- The Multifacet Brilliants

Practically all of the multifacet brilliants are round in outline, and have about 100 facets or more. They are designed especially for low R.I. materials and are best in sizes above 15 millimeters. Many of them are unsatisfactory in weights under fifty carats. The group as a whole is not difficult to cut.

Diagram 21, Sparkler Cut

The sparkler cut works well with low R.I. materials in gems of 15 to 25 millimeter sizes. A dark color is not satisfactory. The cut adds good scintillation by having both the horizontal and vertical facets split. It is easy to do, and may be done on any eight-fold index.

The preform is the medium depth, curved cone of the simpler multifacet type.

Diagrams 22 and 23, The Double Diamond Cuts

These two cuts are very similar, and differ in that one has the main facets split vertically, the other horizontally. Each may be cut on any eight-fold index. The vertical split form would be best in sizes from 10 to 15 millimeters. The horizontal split version offers more scintillation and will be good in sizes of 15 to 25 millimeters. Both cuts are good with light colored materials.

The preforms should be the deep curved cone for the multifacet brilliants.

Diagram 24, Portuguese Cut

The Portuguese cut is probably the finest cut for large stones. Other cuts with as many or more facets might produce even more scintillation, but the staggering of the facets on both the pavilion and crown of this cut tends to give the returning light a look as if it were being spiraled through the stone. The basic cut may be varied by changing angles to give more or less facet rows. It may be adapted to an oval by progressively changing angles while changing quill elevations. This cut and any variations is satisfactory in sizes from 15 to 40 mm.

The preform should be deep and must have the decided curve shown in Figure 82A, Page 190. The depth and curve must be altered in accordance with any changes of the basic pattern.

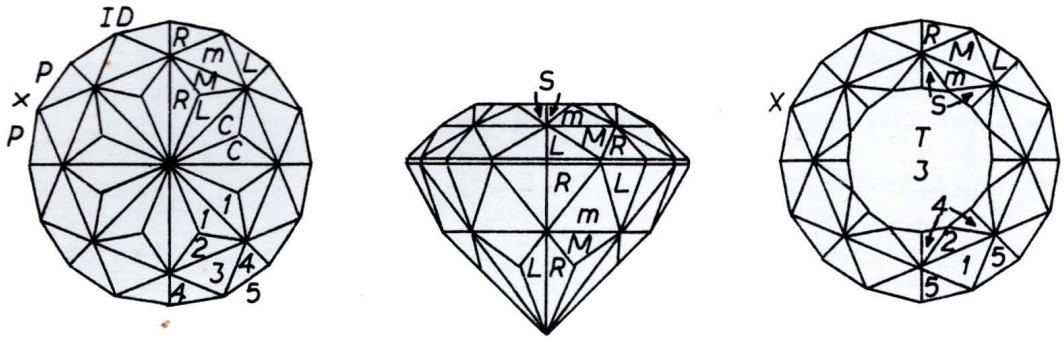
Diagram 25, Scotch Brilliant

This is an interesting cut composed of step and brilliant facets. Half of the pavilion is of brilliant type facets. It offers most of the advantages of the multifacet brilliants, but should be used only for stones greater than 30 mm. The directions are for a 64 index, but the number of facets may be increased by using the 96 index, and placing that number of facets around the girdle. The cut may also be reduced by the use of the 32 index, with that number of facets around the girdle. There is nothing difficult about the cut with any index.

The preform should be the deep curved shape of the multifacet brilliants.

SPARKLER CUT

(see page 133)



PAVILION- eight-fold symmetry, 32 index, using all main settings and all break settings. For 64, 96, or 120 index, see the eight-fold transposition chart.

1- establish the settings (asterisk mains) on which the main facets of step 2 are to be cut. Cut sixteen culet facets (C) at culet angle, on break settings adjacent to these asterisk main settings. With 64 index, skip one setting; 96 index, skip two settings; and with 120 index index, skip three settings on each side of the main. The culet facet length must be about three-fourths the depth of the pavilion.

2- eight main facets (M) at culet angle plus 10°. These should bring the culet facets to a point two-thirds of the way from culet to girdle.

3- eight split main facets (m) at culet angle plus 15°, on step 2 settings. These should extend well into the girdle area; if not, increase the angle.

4- sixteen break facets (R&L) at culet angle plus 20° to 25°, on the settings used in step 1.

5- sixteen girdle facets at 90°, on the settings used in step 4.

Suggested polishing order; 1 to 4 as cut, and two girdle facets (P), one to each side of a main (X).

CROWN- all facets are cut on the same settings used for the pavilion. Align stone by indexing the point (X) to a main setting, and placing one of the polished girdle facets (P) flat to the polishing lap. Polish the girdle.

1- cut eight main facets (M) at crown angle plus 10°, on the eight-fold asterisk main settings. These should extend about three-fourths of the way from girdle to table area. Leave the correct amount of girdle.

2- eight secondary main facets (m) at crown angle, on step 1 settings. These extend to table area, and meet the mains (M) at two-thirds of the way from the girdle.

3- cut the table (T) at 0°, to where its width is 60% of the stone width, or to where the mains meet as above.

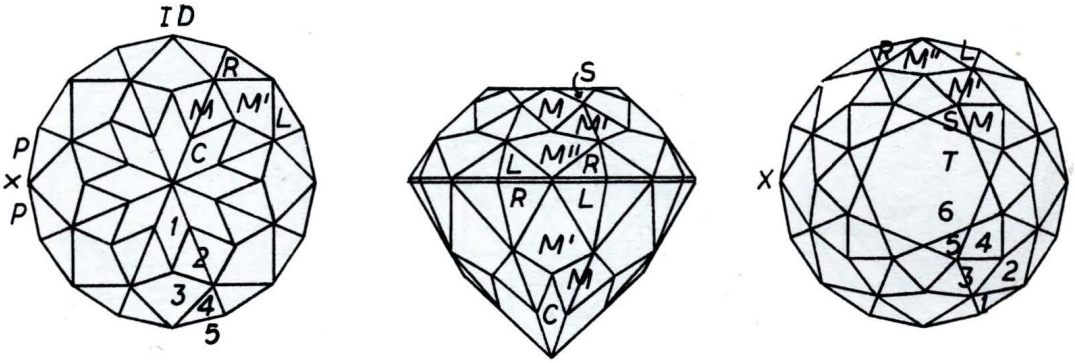
4- sixteen star facets (S) at crown angle less 6° to 10°, on settings used for the girdle. The star points must meet the junction of facets (M&m).

5- sixteen break facets (R&L) at crown angle plus 15° to 20°, on step 4 settings.

Suggested polishing order; 3-4-2-1-5.

DOUBLE DIAMOND CUT
(Vertical split mains)

(see page 133)



PAVILION- eight-fold symmetry, 32 index, using all mains and break settings. For 64, 96, or 120 index, see the eight-fold transposition chart.

1- cut eight culet facets (C) at culet angle, on the eight-fold asterisk main settings.

2- sixteen split main facets (M) at culet angle plus 7°, on break settings adjacent to step 1 settings. For indexes greater than 32, it will be necessary to skip one or more settings on each side of the culet settings, The split mains are cut, each half alternately, until they are mirror images.

3- eight main facets (M') at culet angle plus 17°, on step 1 settings.

4- sixteen break facets (R&L) at culet angle plus 22° to 28°, on step 2 settings.

5- sixteen girdle facets at 90°, on step 4 settings.

Suggested polishing order; 1 to 4 as cut. Polish one girdle (P), on each side of a main (X).

CROWN- 32 index, using all settings. Align stone by indexing the point (X) to an asterisk main setting, and placing one of the polished girdle facets (P), flat to the polishing lap. Polish the girdle.

1- cut sixteen break facets (R&L) at crown angle plus 28°, on the break settings used to polish girdle. Leave the correct girdle height.

2- eight main facets (M'') at crown angle plus 10°, on the eight-fold asterisk main settings.

3- sixteen split main facets (M') at crown angle, on step 1 settings.

4- eight main facets (M) at crown angle less 5°, on step 2 settings.

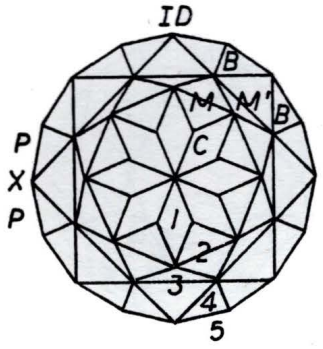
5- eight star facets (S) at crown angle less 15°, on star settings midpoint of step 4 settings.

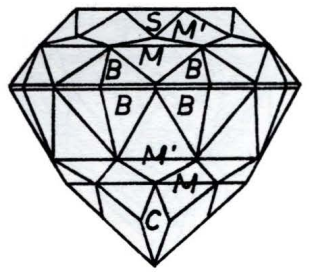
6- cut the table (T) at 0°, to where its edge touches the juncture of stars (S) and mains (M).

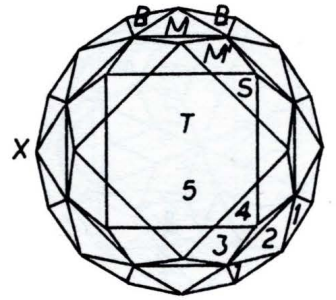
Suggested polishing order; 6-5-4-3-2-1.

DOUBLE DIAMOND CUT
(Horizontal split mains)

(see page 133)







PAVILION- eight-fold symmetry, 32 index, using all settings. For 64, 96, or 120 index, see the eight-fold transposition chart.

1- cut eight culet facets (C) at culet angle, on eight-fold asterisk main settings.

2- eight horizontal split mains (M) on star settings midpoint of step 1 settings. The half between the culet facets is cut at culet angle plus 7°, the other half is 5° greater.

3- eight split mains (M') on step 1 settings. The half touching the culet facets is cut at culet angle plus 19°, the other half is cut 5° greater, and touches the girdle.

4- sixteen break facets (R& L) at culet angle plus 35° to 45°, on settings midpoint of steps 1 and 2.

5- sixteen girdle facets at 90°, on step 4 settings.

Suggested polishing order; 1-2-3-4. Polish one girdle facet (P) on each side of a main (X).

CROWN- 32 index, using all settings. Align stone by indexing the point (X) to a main setting, and placing one of the polished girdle facets (P) flat to the polishing lap. Polish the girdle.

1- cut sixteen break facets (R& L) at crown angle plus 30°, on the settings used to polish the girdle.

2- eight split main facets (M) on the eight-fold asterisk main settings. The half touching the girdle is cut at crown angle plus 15°, with the other half cut 5° less.

3- eight main facets (M') at crown angle, on star settings midpoint of step 2 settings.

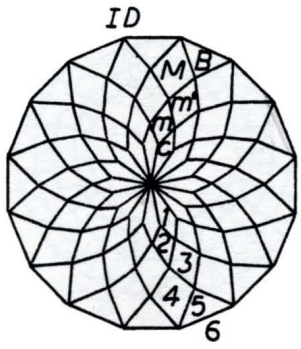
4- eight star facets (S) at crown angle less 15°, on step 2 settings.

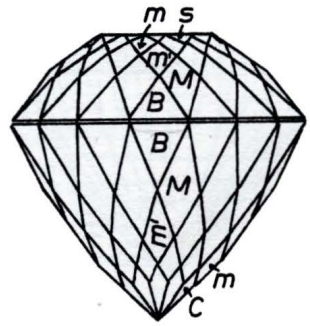
5- cut the table (T) at 0°, to where its edge touches the juncture of the star facets (S) and main facets (M').

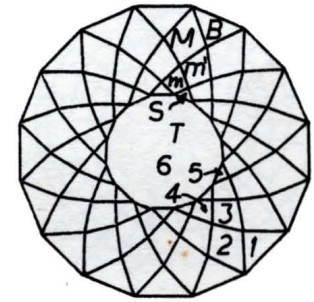
Suggested polishing order; 5-4-3-2-1.

PORTUGUESE CUT

(see page 133)







PAVILION- sixteen-fold symmetry, 32 index, using all settings. The 96 or 120 index is not satisfactory.

1- cut sixteen culet facets (c) at culet angle, on sixteen equidistant settings.

2- sixteen secondary main facets (m) at culet angle plus 5°, on settings midpoint of step 1.

3- sixteen secondary main facets (m') at culet angle plus 10°, on step 1 settings.

4- sixteen main facets (M) at culet angle plus 15°, on step 2 settings. These mains touch the girdle area.

5- sixteen break facets (B) on step 3 settings, at culet angle plus 20°, or at the necessary angle to make the break facets touch the tips of main facet (m'), and also meet adjoining breaks around the girdle.

6- sixteen girdle facets at 90°, on step 5 settings.

Suggested polishing order; 1 to 5. Do not polish girdle.

CROWN- all facets are cut on the same settings used for the pavilion. Align stone by indexing any girdle facet to a step 6 pavilion setting, and placing it flat to the polishing lap. Polish the girdle.

1- cut sixteen break facets (B) at crown angle plus 10°, on the settings used to polish the girdle.

2- sixteen main facets (M) at crown angle, on the settings midpoint of step 1 settings.

3- sixteen secondary main facets (m') at crown angle less 5°, on step 1 settings.

4- sixteen secondary mains (m) at crown angle less 10°, on step 2 settings.

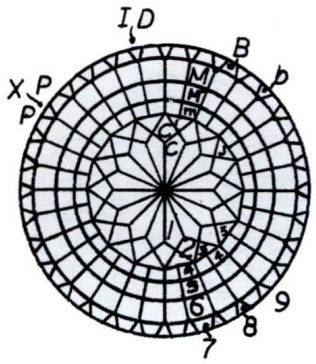
5- sixteen star facets (S) at crown angle less 15°, on step 3 settings.

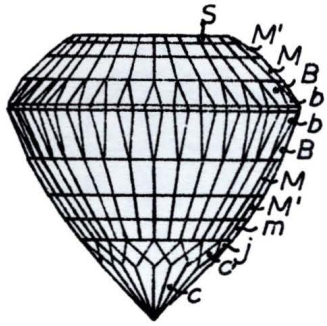
6- cut the table (T) at 0°, to where its edge touches the tips of the secondary mains (m).

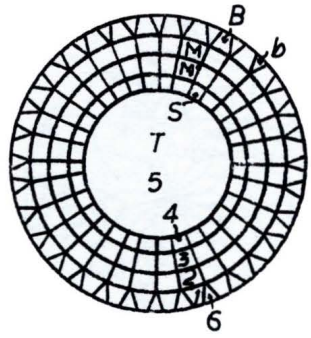
Suggested polishing order; 6-5-4-3-2-1.

SCOTCH CUT

(see page 133)







PAVILION- sixteen-fold symmetry, 64 index, using all settings. For other indexes, see the correct transposition chart.

1- sixteen culet facets (c) at culet angle angle, on all main settings.

2- sixteen secondary culet facets (c') at culet angle plus 2°, on settings midpoint of step 1 settings.

3- sixteen junction facets (j) at culet angle plus 5°, on step 1 settings.

4- thirty-two accessory mains (m) at culet angle plus 10°, on break settings midpoint of step 2 & 3 settings.

5- thirty-two main facets (M') at culet angle plus 15°, on step 4 settings.

6- thirty-two main facets (M) at culet angle plus 20°, on step 5 settings.

7- thirty-two break facets (B) at culet angle plus 25°, on step 6 settings.

8- thirty-two accessory break facets (b) at culet angle plus 27° to 30°, on step 2 and 3 settings. These break the girdle into sixty-four equal divisions.

9- sixty-four girdle facets at 90°, on step 7 and 8 settings.

Suggested polishing order; 1 to 8 as cut, and two step 7 girdle facets (P), one to each side of a main (X).

CROWN- all facets are cut on the same settings as step 4 to 8 of the pavilion. Align stone by indexing the unpolished girdle facet (X) to a main setting and placing it flat to the polishing lap. The polished girdle facets (P) are now indexed to break settings. Polish the girdle.

1- thirty-two break facets (B) at crown angle plus 15°, on break settings (P) of pavilion step 7.

2- thirty-two main facets (M) at crown angle, on step 1 settings.

3- thirty-two main facets (M') at crown angle less 7°, on step 2 settings.

4- thirty-two star facets (S) at crown angle less 15°, on step 3 settings.

5- cut the table (T) at 0°, to where it reduces the star facets (S) to the desired size.

6- thirty-two accessary break facets (b) at crown angle plus 17° to 20°, at midpoint of step 4 settings. These should equal the width of the girdle facets beneath.

Suggested polishing order; 5-4-3-2-6-1.

This cut may easily be adapted to any larger or smaller index, using all settings. The same midpoint settings as above must be observed.

SECTION V

Diagrams 26 to 33 -- The Step Cuts

The step cuts are not difficult to execute, and if done with colored materials, as intended, the results are usually very satisfactory. It is generally true that the step cuts have the decided limitation in that they return little brilliance and poor scintillation. There are a few exceptions, such as the step shield, Diagram 29, but the faceter cannot expect a lively stone from this group.

The step cut diagrams are based on a stone of medium depth, and the faceter should feel free to decrease or increase this depth if there is a good reason to do so. The preform for this medium depth stone is suggested to conform with Figure 82A, Page 190. Any changes as suggested above will be reflected in the depth of the preform.

The cutting directions here suggest the cutting of the girdle after the longer pavilion facets are in place. The authors have found that most faceters tend to produce a preform that is too shallow. If this is the case, the placing of the culet facets first, and the girdle later is almost mandatory. On the other hand, the girdle may be cut first, if the preform is of the correct depth. The placement of the girdle first is usually helpful in guiding one in placing most other facets. The placing of the girdle as the first act is really the better course, but if the preform is not deep enough the girdle will need to be recut later. This will result in only a waste of time with waste of material taking place no matter how the stone is started. The faceter has the privilege of cutting the girdle first, or at the point suggested in the cutting directions.

Diagram 26, Simple Step Cut

This cut as shown is seldom used for stones above a carat in weight unless they have a very rich color. It is often done in very small stones, called baguettes, which are used to surround large rectangular gems or are mounted at the sides of ring settings. Its most important significance to the faceter is that it is the basis for the freeform.

The preform is the typical deep, curved step type as shown in Figure 82.

Diagram 27, Emerald Cut

The emerald cut is used to enhance colors of light to medium hues in the lower R.I. materials. It was designed for use with emeralds as the name implies. Throughout the literature a number of emerald cuts are pictured, many of them differing from the one shown here. A close examination will show that all have the same general characteristics. This cut will work well with stones of almost any size. Gems over 40 millimeters in longest dimension, however, are best done as some modification.

The preform is the typical deep, curved pavilion type.

Diagram 28, Cushion Cut

The name of this cut undoubtedly is derived from the similarity to cushions found on formal furniture of the past. Being a simple step cut in essence, it must be used with material of medium or slightly darker hue, with little

attention paid to brilliance. It may be cut in almost any size, but gems longer than 30 millimeters are not very interesting.

The shape used in the diagram is probably the most common, but it may be varied to a narrower or wider outline, and thus may be cut with an index of other symmetry. Variation will not greatly improve the scintillation of the cut, but the placing of small facets at the corners could possibly help.

The preform should be deep and curved, and the outline should conform to the desired final shape.

Diagram 29, Step Cut Shield

Even though this is a very simple cut, it returns an excellent amount of brilliance. This is due in part to the acute angle on the three corners at the girdle. Reflection across these corners results in returning some light that would ordinarily be lost. The diagram gives directions for the 48 index, which will produce a perfectly symmetrical stone. It may be cut on almost any index, and a slightly asymmetrical stone will be satisfactory. It is possible to produce the true shield shape, that of a shorter horizontal dimension, and have a fine gem.

The stone is not a true hexagon, and the preform should be carefully ground to this pseudo-hexagonal shape. The preform can be a true hexagon with the excess cut away on the faceting lap. This is satisfactory if the material is the more reasonably priced low R.I. type for which the cut is intended. A size maximum of 20 mm should be observed.

Diagram 30, Round Step Cut

This cut could easily be classified as a multifacet brilliant, but regardless of the classification, it is simple and easy to do. The cut is very brilliant, and scintillation is good. It is excellent for light-colored materials of low R.I. in sizes up to 20mm. The extra depth will darken colors. The single needle tourmalinated quartz stone in Figure 34, Page 51 was done with this cut.

The preform should be the usual deep multifacet type.

Diagram 31, Oval Step Cut

This cut does not return much brilliance, but is good with medium to dark materials. The diagram uses the twelve-fold index, but any index necessary to achieve a certain outline should be satisfactory.

The preform should conform to the desired ouline and pavilion depth.

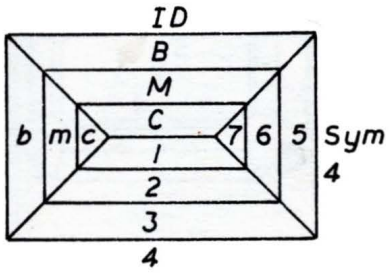
Diagrams 32 and 33, The Irregular Ovals

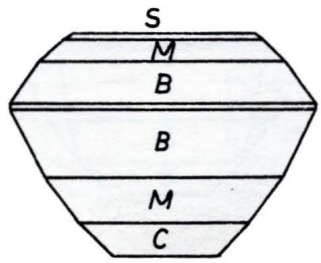
These are two interesting modifications that are useful for medium colored materials. The squared step oval returns good scintillation, and is suitable for use with large stones of light to medium color. The bathtub cut also returns good scintillation, and is excellent to show color. Stones of about 100 carats or larger are excellent gems. This cut has proven superior with kunzite.

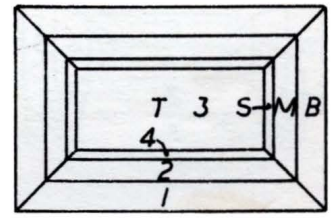
The preform of each of these cuts is of the usual deep curved step type, with the outline conforming to intended final stone shape.

SIMPLE STEP CUT

(see page 139)







PAVILION- four-fold symmetry, 32 index, using alternate eight-fold asterisk main settings.

1- cut two long culet facets (C) at culet angle, on ID setting and its opposite, to one-third of the pavilion depth.

2- two long main facets (M) at culet angle plus 10°, on step 1 settings. These should reduce the culet facets to about 25% of the pavilion depth.

3- two long break facets (B) at culet angle plus 20°, on step 2 settings. These should be about 50% of the pavilion depth, and reduce the mains (M) to about 30% of the pavilion depth.

4- two girdle facets at 90°, on step 3 settings, and two girdle facets on symmetry (Sym) setting and its opposite. The stone should now be a perfect rectangle.

5- two end break facets (b) at culet angle plus 20°, on the end settings of step 4. The break and girdle facets must meet perfectly at the corners.

6- two end main facets (m) at culet angle plus 10°, on step 5 settings. These must match both long mains (M). If not, cut to the lower long main, and recut the higher long main to match.

7- two end culet facets (c) at culet angle, on step 6 settings. Correct any mismatching as in step 6.

Suggested polishing order; 1&7, 2&6, 3&5. Do not polish the girdle.

CROWN- all facets are cut on the same settings as their counterparts on the pavilion. Align stone by indexing one of the long girdle facets to the ID setting, and placing it flat to the polishing lap. Polish the girdle.

1- cut four break facets (B) at crown angle plus 15°, on all four settings. Leave the correct amount of girdle height at this step.

2- four main facets (M) at crown angle. These should be about the same height as the break facets.

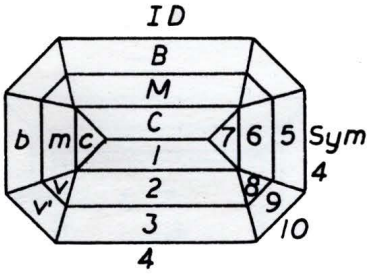
3- cut the table (T) at 0°, to where its width is about 45% on the stone width.

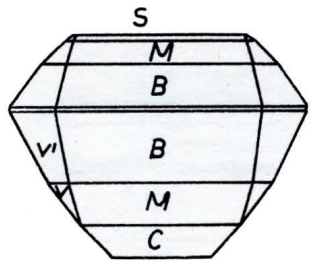
4- four star facets (S) at crown angle less 15°. These are narrow facets, and should reduce the main (M) to where it is smaller than the break (B).

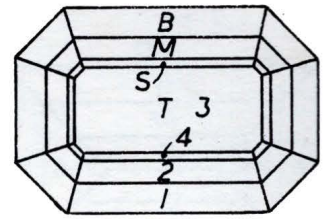
Suggested polishing order; 3-4-2-1.

EMERALD CUT

(see page 139)







PAVILION- eight-fold symmetry, using only the eight asterisk (*) settings of any eight-fold index.

1- cut two long culet facets (C) at culet angle, on ID setting and its opposite, to about 33% of the pavilion depth.

2- two long main facets (M) at culet angle plus 10°, on step 1 settings. These should reduce the culet facets to about 25% of the pavilion depth.

3- two long side break facets (B) at culet angle plus 20°, on step 2 settings. These should be about 50% of the pavilion depth, and reduce mains (M) to about 30% of the pavilion depth.

4- two girdle facets at 90°, on step 3 settings, and two girdle facets on symmetry setting and its opposite.

5- two end break facets (b) at culet angle plus 20°, on the end settings of step 4. Break and girdle facets must meet perfectly at the corners.

6- two end main facets (m) at culet angle plus 10°, on step 5 settings. These must match both long mains (M). If not, cut to the lower one, and recut the higher one to match.

7- two end culet facets (c) at culet angle, on step 6 settings. Correct any mismatching as in step 6.

8- four corner main facets (v) at culet angle plus 10°, on settings midpoint of steps 3 & 5. The points should touch the juncture of facets (c&C).

9- four corner break facets (w') at culet angle plus 20°, on step 8 settings.

10- four corner girdle facets at 90°, on step 9 settings. These will close the pavilion.

Suggested polishing order; 1&7, 2, 6&8, 3, 5&9. Do not polish the girdle.

CROWN- all facets are cut of the same settings as their counterparts on the pavilion. Align stone by indexing one of the long girdle facets to a main setting, and placing it flat to the polishing lap. Polish the girdle.

1- cut eight break facets (B) at crown angle plus 15°, on the settings used to polish the girdle. Leave the desired amount of girdle height.

2- eight main facets (M) at crown angle on step 1 settings. These should be about the same height as the break facets (B).

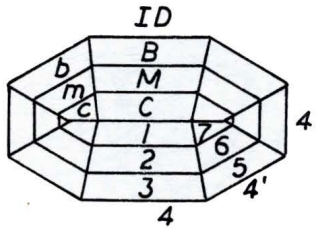
3- cut the table (T) at 0°, to where its width is about 45% of the stone width.

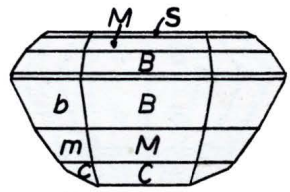
4- eight star facets (S) at crown angle less 15°, on step 2 settings. These are narrow facets and reduce the main (M) to where it is slightly smaller than the breaks (B).

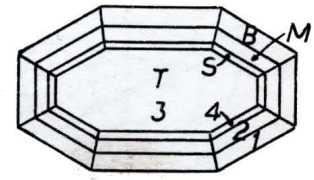
Suggested polishing order; 3-4-2-1.

STEP CUT CUSHION

(see page 139)







PAVILION- eight-fold symmetry, 48 index, using only eight of the twelve main ssttings. For 96 or 120 index, see the six-fold transposition chart.

1- cut two long culet facets (C) at culet angle, on ID setting and its opposite.

2- two long main facets (M) at culet angle plus 10°, on step 1 settings.

3- two long break facets (B) at culet angle plus 20°, on step 2 settings.

4- eight girdle facets at 90°. Two on step 3 settings, two on symmetry setting and its opposite, and four on main settings adjacent to step 3 settings.

5- six break facets (b) at culet angle plus 20°, on step 4 settings, omitting ID setting and its opposite.

6- six main facets (m) at culet angle plus 10°, on step 5 settings. The juncture of the mains with breaks must be a perfect line.

7- six culet facets (c) at culet angle, on step 6 settings.

Suggested polishing order; 1-7-2-6-3-5. Do not polish girdle.

CROWN- all facets are cut on the same settings as their counterparts on the pavilion. Align stone by indexing a long girdle facet to the ID setting, and placing it flat to the polishing lap. Polish the girdle.

1- cut eight break facets (B) at crown angle plus 15°, on the settings used to polish the girdle. Leave correct amount of girdle at this step.

2- eight main facets (M) at crown angle, on step 1 settings. The main mains and breaks (B) should be about equal in height.

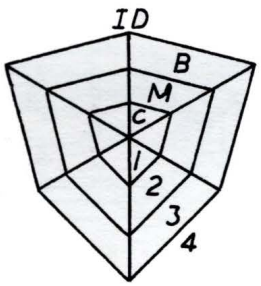
3- cut the table (T) at 0°, to where its width is 50% of the stone width, or to where it makes the main and break facets equal in height.

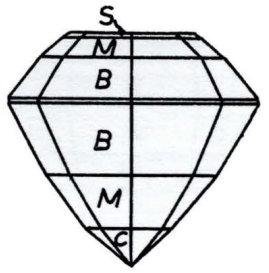
4- eight star facets (S) at crown angle less 15°, on step 2 settings, to where they reduce the main facets to about two-thirds the height of the break facets.

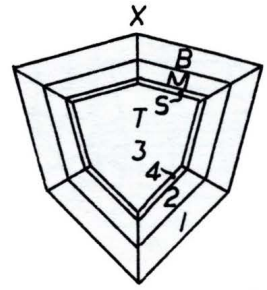
Suggested polishing order; 3-4-2-1.

STEP SHIELD

(see page 140)







PAVILION- three-fold symmetry, 48 index, using three pair of star settings adjacent to three alternate asterisk main settings. This is accomplished by skipping one (break) setting to each side of the three main settings. For 96 or 120 index, see the six-fold transposition chart.

1- cut three pair of culet facets (c) at culet angle. Start with the pair of stars adjacent to the ID setting, and then move one-third of the way around the index to the next pair of stars.

2- six main facets (M) at culet angle plus 10°, on step 1 settings. The main facets should be slightly taller than the culet facets.

3- six break facets (B) at culet angle plus 20°, on step 2 settings. The breaks are the largest of the three sets of facets, and must reach the girdle area.

4- six girdle facets at 90°, on step 3 settings.

Suggested polishing order; 1-2-3. Do not polish girdle.

CROWN-all facets are cut on the same settings as their counterparts on the pavilion. Align stone by indexing one of the points (X) to the ID setting. Place an adjoining girdle facet, now indexed to a star setting, flat to the polishing lap. Polish the girdle.

1- cut six break facets (B) at crown angle plus 15°, on the settings used to polish the girdle. Leave the correct amount of girdle at this step.

2- six main facets (M) at crown angle, on step 1 settings.

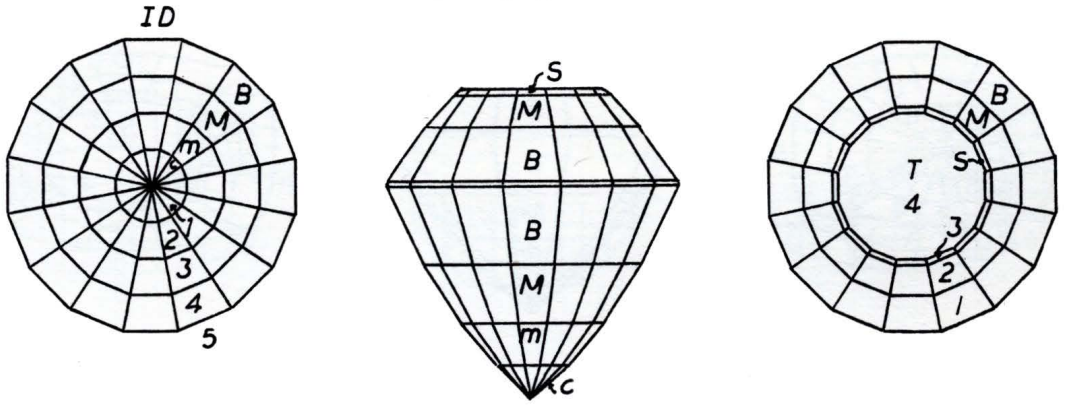
3- cut the table (T) at 0°, to where the main and break facets (M&B) are approximately the same height, or where the table is about 50% of the stone width.

4- six star facets (S) at crown angle less 15°, on step 2 settings, to where the main facet (M) is smaller than the break (B). The star facets should be smaller than the mains.

Suggested polishing order; 3-4-2-1.

ROUND STEP CUT

(see page 140)



PAVILION- sixteen-fold symmetry. All facets are cut on sixteen equi-distant settings. For 32 index, use alternate (main and star) settings; for 64 index, use every fourth (main) setting; for 96 index, use every sixth setting. The 120 index will not be satisfactory.

1- sixteen culet facets (c) at culet angle.

2- sixteen secondary main facets (m) at culet angle plus 7°.

3- sixteen main facets (M) at culet angle plus 14°.

4- sixteen break facets (B) at culet angle plus 21°.

Suggested polishing order; 1-2-3-4. Do not polish girdle.

CROWN- all facets are cut on the same settings as their counterparts on the pavilion. Align stone by indexing any girdle facet to any setting used on the pavilion, and placing it flat to the polishing lap. Polish the girdle.

1- sixteen break facets (B) at crown angle plus 15°.

2- sixteen main facets (M) at crown angle.

3- sixteen star facets (S) at crown angle less 15°. Step 1, 2, & 3 facets decrease in height, to where step 3 stars are the smallest.

4- cut the table (T) at 0°, to where it reduces the star facets to about half the height of the mains. The table should be about 40% to 45% of the stone width.

Suggested polishing order; 4-3-2-1.

Step Rose

The pavilion above may be adapted into a rose cut by using the above cutting steps and the following angles. These angles may be varied if desired.

1- sixteen apex facets (c) at 25°.

2- sixteen secondary main facets (m) at 30°.

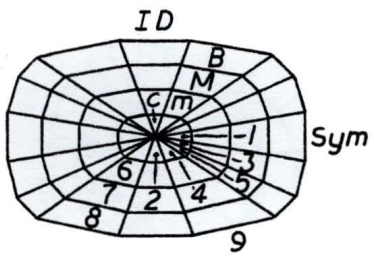
3- sixteen main facets (M) at 35°.

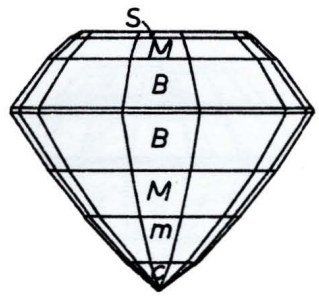
4- sixteen break facets (B) at 40°.

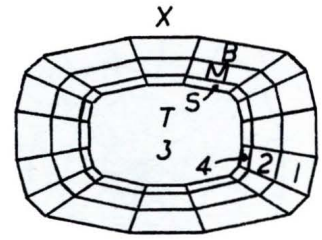
5- sixteen girdle facets at 90°.

OVAL STEP CUT

(see page 140)







PAVILION- eight-fold symmetry, 32 index, using all eight-fold asterisk settings, and midpoint star settings.

1- cut two culet facets (c) at culet angle, on symmetry (Sym) setting and its opposite.

2- two culet facets at culet angle plus 4°, on ID setting and its opposite.

3- four culet facets at culet angle plus 1°, on star settings adjacent to step 1 settings.

4- four culet facets at culet angle plus 3°, on star settings adjacent to step 2 settings.

5- four culet facets at culet angle plus 2°, on main settings midpoint of steps 1 and 2.

6- sixteen secondary main facets (m) at culet angle plus 7° to 18°, on step 1 to 5 settings. The step 1 setting facet is cut at plus 7°; the others with the same progression as above. All angles may need to be adjusted to conform with the oval dimensions.

7- sixteen main facets (M) at culet angle plus 14° to 25°, on step 1 to 5 settings. The step 1 setting facet is again cut at the minimum angle.

8- sixteen break facets (B) at culet angle plus 21° to 33°, on step 1 to 5 settings. The step 1 setting is again cut at the minimum angle.

9- sixteen girdle facets at 90°, on step 8 settings.

Suggested polishing order; all culets (c), all mains (m), all mains (M), all breaks (B). Do not polish girdle.

CROWN- all facets are cut on the settings of their counterparts on the pavilion. Align stone by indexing a side girdle facet (X) to the ID setting, and placing it flat to the polishing lap. Polish the girdle.

1- cut sixteen break facets (B) at crown angle plus 15°.

2- sixteen main facets (M) at crown angle. These must be slightly taller than the break facets; if not, lower the angle until they are.

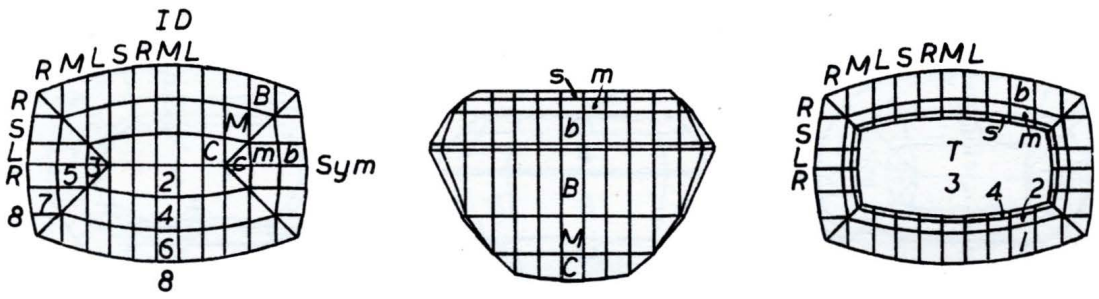
3- cut the table (T) at 0°, to 50% of the stone width, or until it cuts the mains to a height about equal to the height of the breaks.

4- sixteen star facets (S) at crown angle less 15°. These should reduce the main facets to where they have a height less than the breaks. If the angle of the main facets was lowered in step 2, the star angle will need to be lowered accordingly.

Suggested polishing order; 3-4-2-1.

SQUARED STEP OVAL

(see page 140)



PAVILION- four-fold symmetry, 96 index only, using adjacent settings in four groups.

1- cut steps 1 through 7 of the simple step cut, diagram 26.

2- seven culet facets (C) on each side of the culet line, at culet angle. This divides the culet line into five equal divisions, plus two triangular facets at each end. Start on the ID setting and its opposite, and use three adjacent settings on each side.

3- four end culet facets (c) at culet angle, on break settings adjacent to the symmetry (Sym) setting and its opposite.

4- eighteen main facets (M) at culet angle plus 10°, on step 2 settings.

5- eight end main facets (m) at culet angle plus 10°, on step 3 settings, plus two adjacent settings.

6- twenty-two break facets (B) at culet angle plus 20°, on step 4 settings.

7- twelve break facets (b) at culet angle plus 20°, on step 5 settings, plus two adjacent settings.

8- thirty-four girdle facets at 90°, on step 6 and 7 settings.

Suggested polishing order; 2 to 7, and the ID setting girdle facet.

CROWN- all facets cut on the same settings as their counterparts on the pavilion. Align stone by indexing the polished girdle facet to the ID setting, and placing it flat to the polishing lap. Polish the girdle.

1- cut thirty-four break facets (B) at crown angle plus 15°, in the same pattern used for the girdle.

2- twenty-six main facets (M) at crown angle, on step 1 settings. Omit two settings at each corner.

3- cut the table (T) at 0°, to where its width is 45% of the stone width.

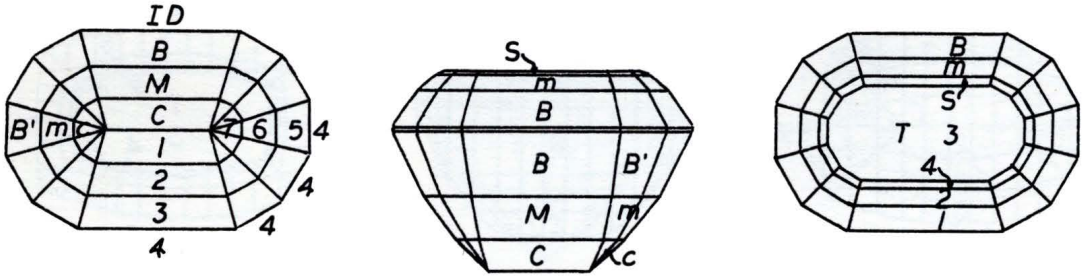
4- twenty-six star facets (s) at crown angle less 15°, on step 2 settings. The star facets should reduce the main facets to about one-half the height of the break facets.

Suggested polishing order; 3-4-2-1.

This cut may also be done with 64 or 120 index, again using adjacent settings. All angles should be the same. The curve of a stone with the 64 index will be greater, and that of the 120 index will be flat. A possible result of this curve change may be more or less facets will be needed at the corners.

BATH TUB CUT

(see page 140)



PAVILION- twelve-fold symmetry, 48 index, using only twelve main settings. For 96 or 120 index, see the six-fold transposition chart.

1- cut two long culet facets (C) at culet angle on ID setting and its opposite.

2- two long main facets (M) at culet angle plus 10°, on step 1 setting.

3- two long break facets (B) at culet angle plus 20°, on step 2 setting.

4-two long girdle facets at 90°, on step 3 setting. At the same angle, on the remaining main settings, cut ten equal-sized girdle facets to round out the ends of the stone.

5- ten end break facets (B') at culet angle plus 20°, on the second group of settings of step 4.

6- ten end mains (m) at culet angle plus 10°, on step 5 settings.

7- ten end culet facets (c) at culet angle, on step 6 settings.

Suggested polishing order; 3-5-2-6-7-1. Do not polish girdle.

CROWN- all facets are cut on the same settings as their counterparts on the pavilion. Align stone by indexing a long girdle facet to the ID setting, and placing it flat to the polishing lap. Polish the girdle.

1- cut twelve break facets (B) at crown angle plus 15°.

2- twelve main facets (m) at crown angle.

3- cut the table (T) at 0°, to where it makes step 1 and 2 facets about equal in height. The table should be about 45% as wide as the stone width.

4- twelve star facets (s) at crown angle less 15°, on step 2 settings. These should be cut to where the height of the main facets is reduced to about two-thirds of the height of the break facets.

Suggested polishing order; 3-4-2-1.

SECTION VI

Diagrams 34 to 40 -- The Mixed Cuts

The hodge-podge group of mixed cuts cannot be easily sorted into sub-groups, and are presented indiscriminately. Some cuts are easy to execute because of their simplicity. The French stars are presented first. The cuts become more complex, but they are not presented in line with increasing complexity.

As a group the mixed cuts are difficult to execute with the individual shape of any particular stone having a great bearing on angles and procedures. These cuts offer the faceter an almost unlimited supply of different cuts.

The preforms for the mixed cuts do not follow any set of specifications, and each must conform to the expected shape of the final gem.

Diagram 34, French Stars

The French star is a very simple cut and excellent for a beginner's first try. The simplicity of the cut leaves much to be desired from the standpoint of brilliance, and is best with medium-colored material.

The preform should be perfectly square with a deep curved pavilion. The crown is not proportionately as deep, and needs to be a truncate pyramid.

The double French star is much superior to that of the foregoing cut. The addition of the split corner main crown facets makes a great difference in the scintillation of light returned, and will intensify the color of medium-hued material. The cut is best used with the low R.I. gem materials. The crown is the basis of what is known as the cardinal cut.

The preform for this cut is identical to that of the French star.

Diagram 35, European Mixed Cut

The symbols on the diagram make this cut look very difficult, but this is not true. As long as the sequence is carried out only minor difficulties will be encountered. The placing of the wing facets is the most difficult. The cut is popular with foreign lapidaries as it is excellent with the medium color hues. It is also a cut that can be adjusted in the event of error, a boon to the cutter using the jamb-peg.

The preform should be a somewhat squared oval, with a deep curved pavilion.

Diagram 36, Scissors Cut

This is an excellent cut for ring stones, and to add variety to a collection. It appears to be best in sizes of about 15 to 25 millimeters in the greatest dimension. The scissors cut has fallen heir to a bad name in recent years because it calls for much material in the pavilion, and with the older method of cutting the crown first, there usually was not ample material to keep the gem from being a fish-eye.

There are a number of methods of executing a scissors cut, and none of them are what might be considered simple. This cut may be done on a 32 or 48 index,

but the 64 and 96 indexes give the greatest possibility of conforming to the various sizes and shapes of facets. Any index used will call for much use of the cheater, but in the experience of the authors, the 64 index calls for the least adjustments. The cutting directions may be easily adapted to the 96 index, using the same named settings. The star settings of the 96 index may be substituted for the break settings given, but will need the cheater.

The cutting directions here tend to produce a gem much deeper than some in the faceting literature, but at least it will not be a fish-eye. It is doubtful if a gem cut by the accompanying directions will fit any commercial mountings designed for rectangular stones, but such mountings are made for the commercially cut stone which usually is a fish-eye.

As this cut does not have many facets, it would do little to enhance the inherent brilliance of high R.I. material. The beauty of this cut lies in the twinkling effect of light moving across the facets, and it finds its greatest usage in gem materials with a R.I. below 1.65. The relative dimensions of the stone have great bearing upon all angles and adjustments during cutting. A stone with dimensions of a length of one and one-half times the width is easiest to cut. With stones of a length greater than one and one-half fimes the width, difficulties are encountered with the change of angles. As the dimensions change toward nearly square, the placement of the wing facets becomes a problem. The increasing of the length over width cannot be carried very far as a stone of about two to one proportions is not pleasing. The best stones lie within size limitations of one and one-third to one, and one and three-fourths to one.

The preform for the scissors cut is different from that required for the step cuts. There are only two facet angles from culet to girdle, and the differential between them is seldom greater than ten degrees. A straight-sided preform about ten degrees above the culet angle should suffice.

Diagram 37, True Mixed Cut

The cut shown in Diagram 37 is commonly called "The Mixed Cut". Others are prefixed by the octagonal mixed, triangular mixed, etc. All are very similar, using the same sequence of settings for the crown with subsequent angle changes. The pavilions are altered only enough to conform to the outline of the girdle. Any change in relative proportions from the shape in the diagram will result in a pronounced change in pavilion and crown break angles. The star angles will also be affected.

The true mixed cuts are excellent for medium to dark material of low R.I., and give a nice return of brilliance and scintillation. Widths up to 30 millimeters are successful.

The preform is the typical deep step pavilion with a somewhat flattened crown.

Diagram 38, Shuttle Cut

The shuttle cut is a very interesting type of mixed cut. It is essentially a step cut, but the pointed ends give the crown some triangular facets. Light return is somewhat like a checkerboard, a phenomenon exhibited by very few cuts. It is excellent in lengths from 10 to 20 millimeters, and with light to medium colors. Material with a R.I. up to 1.65 responds very well to this cut.

If the gem is to be set in jewelry, the pointed ends may be truncated to lower the possibility of chipping.

The preform should be a deep step type conforming to the general outline with the crown being a gentle curve from end to end. If the stone is to follow the diagram, the relative dimensions must be exactly adhered to. The diagram as shown has dimensions of 2. 29 to one.

Diagram 39, The Tablet Cuts

Strictly speaking, the tablets are not mixed cuts, but they are included here because of their possible wide diversity. To reduce the tablets to the simplest definition it can be said that the crown of any cut can be adapted into a tablet. This can be done by the simple expedient of reducing angles and the number of facets, with a subsequent enlargement of the table. The diagram offered here shows a few of the possibilities with the combining of two crowns to produce a lozenge-shaped figure.

It might appear that such a simple cut might not have much use, but this is far from correct. The triangular tablet cut as shown in Figure 35, Page 51 shows off an intriguing network of rutile in quartz. It will work for any inclusion in any gem mineral. The tablet can be of further use with very dark material of a rich color that would not respond to a conventional cut. Dark red garnets, deep colored tourmalines, and amethysts beg for this treatment. As there is little brilliance to be returned with this cut, except around the edges, the refractive index of the material, and the cutting angles are of little importance. Shape of rough is probably the most important feature to guide one to using this type of cut. How else would one use a thin flat piece of beautifully colored rough?

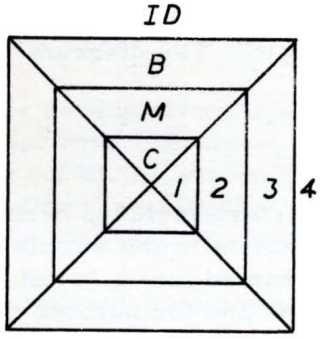
The prefrom will depend upon many factors and no rule can be set. All that might be necessary in preforming would be to flatten the two tables and perhaps roughly grind in the outline. If a thin section of a crystal were being used, the faceter might leave the crystal outline as the outline of the stone. In this case only the tables would be ground to flatness.

Diagram 40, Beads and Spheres

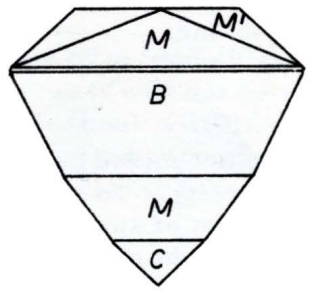
The cutting of a bead or sphere is not as difficult as may be thought. Each is in reality a derivation of one of the more usual cuts. The step bead is a derivation of the round step cut, Diagram 30, with the culet replaced by a cap facet, or a group of small facets. The brilliant bead is a derivation of the Portuguese cut, Diagram 24, with the culet again handled in the same manner.

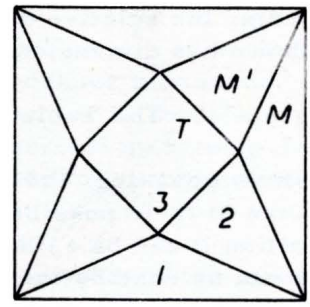
THE FRENCH STAR CUTS

(see page 149)



French Star





PAVILION- four-fold symmetry, 32 index, using alternate eight-fold asterisk main settings.

1- cut four culet facets (C) at culet angle, on four asterisk settings.

2- four main facets (M) at culet angle plus 10°, on step 1 settings.

3-four break facets (B) at culet angle plus 20°, on step 2 settings.

4- four girdle facets at 90°.

Suggested polishing order; 1-2-3. Do not polish girdle.

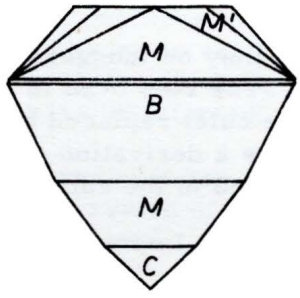
CROWN- 32 index, using all asterisk main settings. Align stone by indexing any girdle facet to the ID setting, and placing it flat to the polishing lap. Polish girdle.

1- cut four side mains (M) at crown angle, on the settings used to polish the girdle.

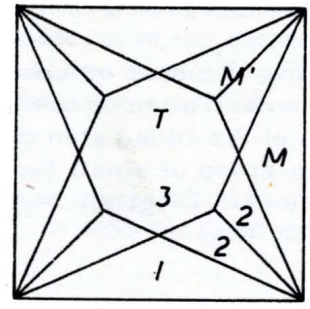
2- four main facets (M') at crown angle less 22°, on settings midpoint of step 2 settings.

3- cut the table (T) at 0°, to the juncture of mains (M&M').

Suggested polishing order; 3-2-1.



Double French Star



PAVILION- identical to the french star above.

CROWN- all facets are cut on the four alternate asterisk settings of the pavilion, plus all star settings. Align stone as for the french star.

1- cut four main facets (M) at crown angle.

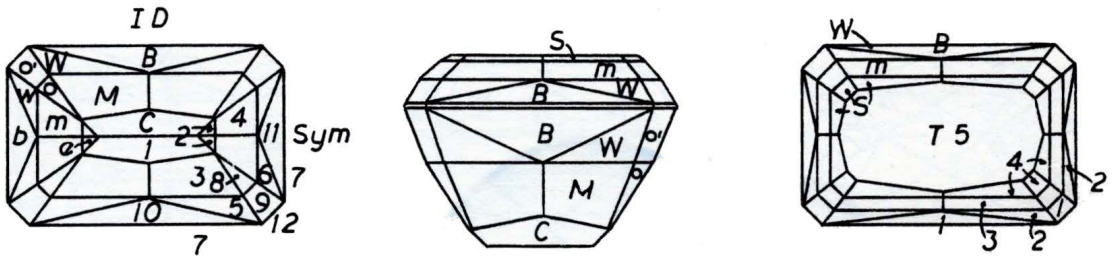
2- four split main facets (M') at crown angle less 20°, on the eight star settings midpoint of the asterisk settings.

3- cut the table (T) at 0°, to the juncture of mains (M) and the split mains (M').

Suggested polishing order; 3-2-1.

EUROPEAN MIXED CUT

(see page 149)



PAVILION- eight-fold symmetry, 96 index, using all eight-fold asterisk settings, and four pair of break settings.

1- cut two culet facets (C) at culet angle, on ID setting and its opposite.

2- four end culet facets (e) at culet angle, on break settings adjacent to symmetry (Sym) setting, and its opposite.

3- four main facets (M) at culet angle plus 15°, on break settings adjacent to step 1 settings.

4- four main facets (m) at culet angle plus 15°, on step 2 settings.

5- four wing facets (W) at culet angle plus 20° to 30°, on step 3 settings.

6- four wing facets (w) at culet angle plus 20° to 30°, on step 4 settings.

7- four girdle facets at 90°. Two on step 1 settings, and two on symmetry (Sym) setting and its opposite.

8- four corner main facets (o) at culet angle plus 15°, on main settings midpoint between step 7 settings.

9- four corner break facets (o') at culet angle plus 25°, on step 8 settings.

10- two long break facets (B) at culet angle plus 30° to 40°, on step 1 settings.

11- two end break facets (b) at culet angle plus 20° to 30°, on symmetry (Sym) setting, and its opposite.

12- four corner girdle facets at 90°, on step 9 settings.

Suggested polishing order; 1-2-3-8-4-5-6-9-10-11. Do not polish girdle.

CROWN- all facets are cut on the settings used for the pavilion. Align stone by indexing a long girdle facet to the ID setting and placing it flat to the polishing lap. Polish the girdle.

1- cut eight break facets (B) at crown angle plus 18°, on the settings used to polish the girdle.

2- eight wing facets (W) at crown angle plus 8° to 15°, on break settings adjacent to ID and symmetry (Sym) settings and their opposites. The side wings will cut at plus 8°, but to match in height, the end wings may need to be cut as much as 5° higher.

3- twelve main facets (m) at crown angle, on step 2 settings, and the corner settings of step 1.

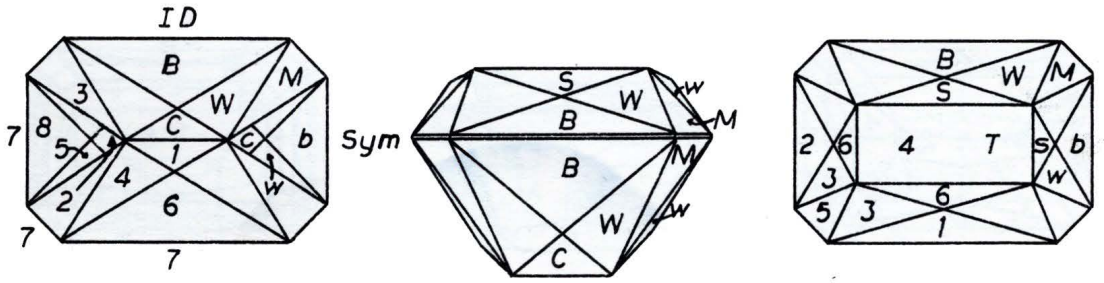
4- twelve star facets (S) at crown angle less 15°, on step 3 settings.

5- cut the table (T) at 0°, to where it reduces step 4 stars to a lesser height than step 3 mains.

Suggested polishing order; 5-4-3-2-1.

SCISSORS CUT

(see page 149)



PAVILION-eight-fold symmetry, 64 index, using the asterisk main settings, and breaks adjacent to four of these mains.

1- cut two culet facets (C) at culet angle, on ID setting and its opposite.

2- two end culet facets (c) at culet angle plus 8°, on symmetry (Sym) setting and its opposite.

3- four corner mains (M) at culet angle plus 8°, at midpoint of steps 1 and 2.

4- four side wing facets (W) at culet angle plus 3° to 10°, on break settings adjacent to step 1 settings. The wings must touch the culet facet junction. overlapping at the sides.

5- four end wing facets (w) at culet angle plus 10° to 15°, on break settings adjacent to step 2 settings.

6- two side break facets (B) at culet angle plus 5° to 15°, on step 1 settings.

7- cut the long girdle facets at 90°, on step 6 settings. These touch the points at the wings. Cut the balance of the girdle to match.

8- two end break facets (b) at culet angle plus 10° to 16°, on step 2 settings.

Suggested polishing order; 1-2-3-4-5-6-8. Do not polish girdle.

CROWN- all facets are cut on the settings of their counterparts on the pavilion. Align stone by indexing a long girdle facet to the ID setting, and placing it flat to the polishing lap. Polish the girdle.

1- cut two side break facets (B) at crown angle plus 13°, on ID setting and its opposite.

2- two end break facets (b) at crown angle plus 10°, on symmetry (Sym) setting and its opposite.

3- four side wing facets (W) and four end wing facets (w) at crown angle, on break settings adjacent to step 1 and 2 settings. The wings must reach the table area, and end in points at the girdle.

4- cut the table (T) at 0°, to where its width is 40% to 50% of the stone width, depending upon the amount of material available.

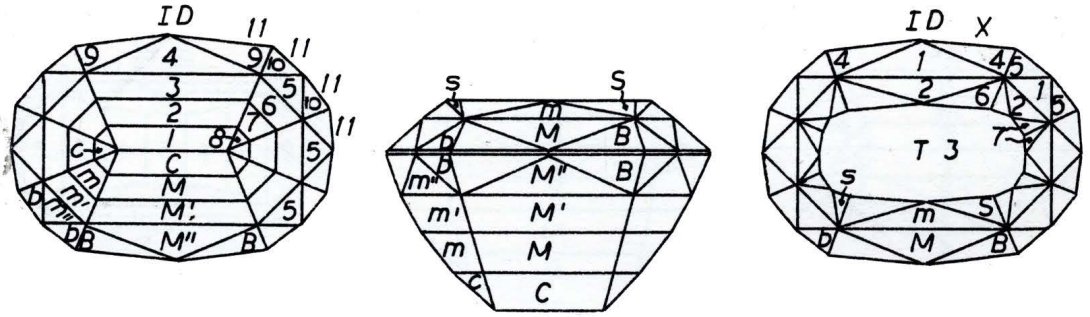
5- four corner main facets (M) at crown angle plus 2° to 10°, on main settings midpoint between those of step 1 and 2.

6- two side star facets (S) and two end star facets (s) at crown angle less 5° to 15°, on step 1 and 2 settings. Both pair of stars will not cut at the same angle.

Suggested polishing order; 4-6-3-5-2-1.

TRUE MIXED CUT

(see page 150)



PAVILION- eight-fold symmetry, 96 index, using all asterisk main, and some star and break settings.

1-2-3-4- eight long side facets. Two culet facets (C) at culet angle; two mains (M) at plus 8°; two mains (M') at plus 16°; and two mains (M'') at plus 24°, on ID setting and its opposite.

5- six end main facets (m'') at culet angle plus 24°, on the remainder of the asterisk settings.

6- six accessory mains (m') at culet angle plus 16°, on step 5 settings.

7- six main facets (m) at culet angle plus 8°, on step 6 settings.

8- six culet facets (c) at culet angle, on step 7 settings.

9- four break facets (B) at culet angle plus 30° to 40°, on break settings adjacent to step 4 settings.

10- twelve break facets (b) at culet angle plus 22° to 32°, on star settings adjacent to step 5 settings. (Skip one setting to each side of step 5 settings).

11- sixteen girdle facets at 90°, on step 9 and 10 settings.

Suggested polishing order; 1-8-2-7-3-6-4-5-9-10. Do not polish girdle.

CROWN- 96 index, all facets are cut on the settings used for the pavilion. Align stone by indexing a long girdle facet (X) to a break setting adjacent to the ID setting, and placing it flat to the polishing lap. Polish the girdle, using pavilion step 11 settings.

1-2- cut eight main facets (M) at crown angle, and eight main facets (m) at crown angle less 6°, on asterisk main settings.

3-cut the table (T) at 0°, to where its width is about 50% of the stone width.

4- four break facets (B) at crown angle plus 12° to 18°, on break settings adjacent to ID setting and its opposite.

5- twelve break facets (b) at crown angle plus 5° to 10°, on star settings adjacent to the asterisk main settings, except ID setting and its opposite.

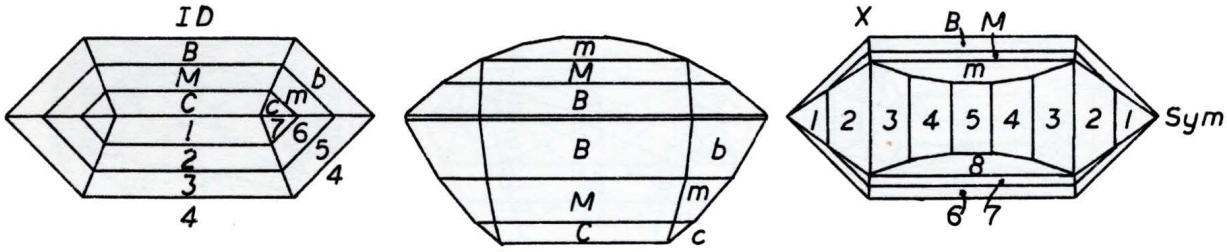
6- four star facets (S) at crown angle less 10° to 20°, on step 4 settings.

7- twelve star facets (s) at crown angle less 13° to 17°, on step 5 settings.

Suggested polishing order; 3-6-7-2-1-4-5.

SHUTTLE CUT

(see page 150)



PAVILION- six-fold symmetry, 32 index, using only six of the eight-fold asterisk main settings. For larger indexes, see the eight-fold transposition chart.

1- cut two long culet facets (C) at culet angle, on ID setting and its opposite.

2- two main facets (M) at culet angle plus 10°, on step 1 settings.

3- two break facets (B) at culet angle plus 20°, on step 2 settings.

4- six girdle facets at 90°, two on step 3 settings, and four on asterisk main settings adjacent to step 3 settings.

5- four end break facets (b) at culet angle plus 20°, on the second group of step 4 settings.

6- four end main facets (m) at culet angle plus 10°, on step 5 settings.

7- four end culet facets (c) at culet angle, on step 6 settings.

Suggested polishing order; 1-7-2-6-3-5. Do not polish girdle.

CROWN- 32 index, all facets cut on the same settings as pavilion with the addition of the group of table facets which use the unused main settings. Align stone by indexing a long girdle facet to the ID setting and placing it flat to the polishing lap. Polish the girdle.

1-2-3-4-5- cut nine table facets, two (1) at 40°; two (2) at 30°; two (3) at 20°; two (4) at 10°; and one (5) at 0°, on symmetry (Sym) setting and its opposite. These are best cut in the 45° dop or equivalent. These facets should be close to equal, across the length of the stone. The junction of 2 and 3 should be slightly toward the center from the corner (X).

6- six break facets (B) at crown angle plus 15°, on the settings used to polish the girdle. The end breaks are cut to the junction of table facets 1 and 2.

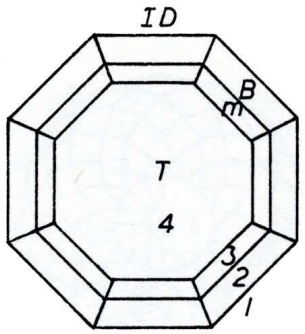
7- six main facets (M) at crown angle, on step 6 settings. These are cut to the junction of table facets 2 and 3.

8- two main facets (m) at culet angle less 15°, on ID setting and its opposite.

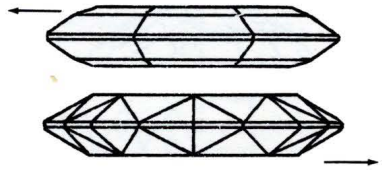
Suggested polishing order; 1-2-3-4-5-8-7-6.

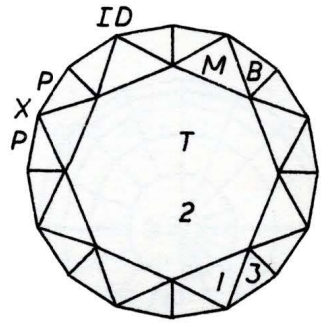
TABLET CUTS

(see page 151)



Step Tablet





Brilliant Tablet

FIRST SIDE- eight-fold symmetry, 32 index, using only the eight-fold asterisk main settings. For larger indexes, see the eight-fold transposition chart.

1- outline the stone by cutting the girdle at 90°. This must be a band of ample width, completely around the stone.

2- eight break facets (B) at 30°, or whatever angle is dictated by the amount of material available.

3- eight main facets (m) at 5° to 10° less than the step 2 angle. This may again depend upon the amount of material available.

4- cut the table (T) at 0°, to where it meets all of the step 3 facets.

Suggested polishing order; 4-3-2. Do not polish the step 1 girdle facets.

SECOND SIDE- all facets are cut on the same settings as their counterparts on the first side. Align stone by indexing any girdle facet to as asterisk setting, and placing it flat to the polishing lap. Polish the girdle.

2-3-4- repeat steps of the first side, cutting the girdle to a thin band.

FIRST SIDE- eight-fold symmetry, 32 index, using the eight-fold asterisk main settings, and the adjacent break settings.

1- cut eight main facets (M) at 30°, on the asterisk main settings. The angle may be adjusted as in step 2 for the step tablet.

2- cut the table (T) at 0°, to where it touches all the main facets.

3- sixteen break facets (B) on break settings adjacent to step 1 settings. These must pinch off the mains at the girdle area (preferably overlapping), and touch the table between the mains. The angle must be found by trial.

4- sixteen girdle facets at 90°, on step 3 settings.

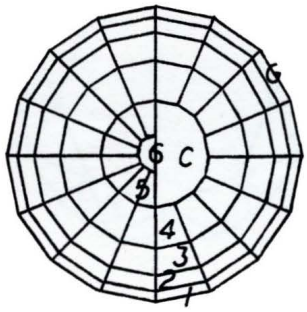
Suggested polishing order; 2-1-3, and one pair of girdle facets (P), one on each side of a main (X).

SECOND SIDE- all facets are cut on the same settings as their counterparts on the first side. Align stone by indexing the point (X) to a main setting, and placing a polished girdle facet (P) flat to the polishing lap. Polish the girdle.

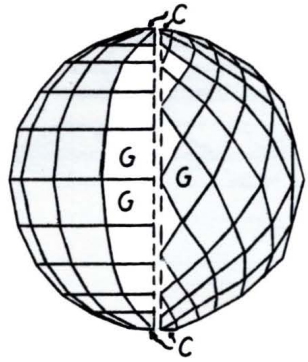
1-2-3- repeat steps of the first side.

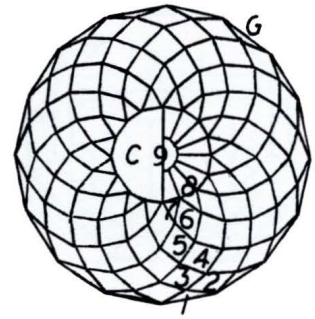
BEADS AND SPHERES

(see page 151)



Step





Brilliant

FIRST SIDE- sixteen-fold symmetry, 32 index, using all asterisk main, and midpoint star settings. For larger indexes, see the eight-fold transposition chart.

1- cut sixteen girdle facets (G) at 80°, on sixteen equidistant settings.

2- sixteen 60° facets, on step 1 settings.

3- sixteen 40° facets, on step 2 settings.

4- sixteen 20° facets, on step 3 settings.

5- sixteen 15° facets, on step 4 settings. Use this step only if the stone is to be a sphere.

6- one cap facet (C) at 0°. If the stone is to be a bead, skip step 5, and cut the cap facet large as in the right of the drawing.

Suggested polishing order; 1 to 6 as cut.

SECOND SIDE- all facets are cut on the same settings as the first side.

1- align stone by carefully cutting and adjusting (at 80°) step 1 facets to match the step 1 facets of the first side. The girdle must be a line meeting perfectly around the stone.

2-3-4-5-6- are repeated as for the first side.

FIRST SIDE- sixteen-fold symmetry, 32 index, using all settings. For larger indexes, see the eight-fold transposition chart.

1- cut sixteen girdle facets (G) at 90°, on eight-fold asterisk main settings, and star settings at midpoint. These must meet around the girdle.

2- sixteen facets at 75°, on settings at midpoint of step 1 settings. These end in an imaginary girdle line.

3-4-5-6-7-8- sixteen facets each, 3 at 61°; 4 at 50°; 5 at 39°; 6 at 30°; 7 at 21°; and 8 at 15°; alternating between step 1 and step 2 settings.

9- if the stone is to be a bead, skip step 8 and cut a large cap facet (C) as at left in the drawing. For a sphere, cut a small cap facet as at right.

Suggested polishing order; 2 to 9 as cut. Do not polish step 1 girdle facets.

SECOND SIDE- all facets are cut on the same settings as the first side. Align stone by indexing any step 1 girdle facet to a main setting, and placing it flat to the polishing lap. Polish the girdle facets.

2-3-4-5-6-7-8-9- are repeated as for the first side. Step 2 facets must touch the tips of the opposite step 2 facets.

SECTION VII

Diagrams 41 to 58

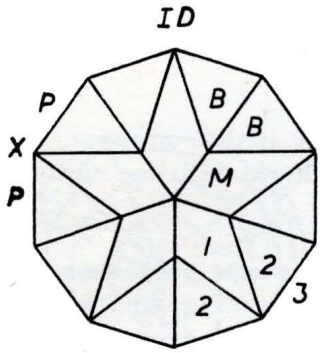
The following group of cutting diagrams is presented with little comment, and with a minimum of cutting directions. Each diagram is shown with the numbered cutting sequence and with the facet name symbol.

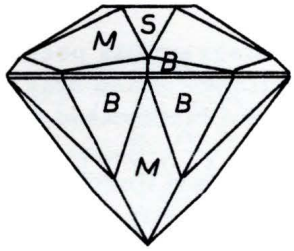
These diagrams are for the most part derivations of other cuts previously discussed. If there is a strong similarity this is noted on the diagram, with the faceter urged to make the comparison to assist in the cutting process. This latter group of diagrams is offered with the more advanced cutter in mind, and it is assumed that the cuts will not be attempted until a reasonable experience has been attained with the foregoing cuts.

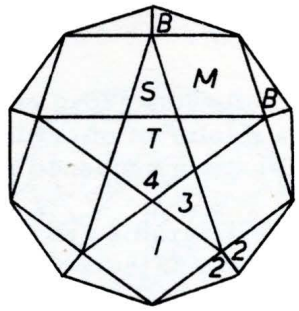
Diagrams 51 through 56 are based on six geometric figures. Each uses the step form as a basis, and shows a number of modifications. Some variations are accomplished by cutting corners, others by changing the angles of the girdle outline. The crowns show a number of variations leading to the mixed cut type. Most of these show the cardinal crown as one variation. The cardinal crown is derived from the double French star, Diagram 34, page 152. There are at least three different cuts on each of these diagrams, and some will offer more. These are presented with the hope that the faceter will be stimulated to improvise and thus develop some new variations of these and other cuts.

The cardinal cut makes use of what is known as the reverse facet; one that has its widest end at the table, and ends at a point at the girdle. The ordinary break facet (the opposite of the reverse) is wide at the girdle and ends at a point at the table or star facet. Other than the inverted position, the reverse facet is little different than the usual break facet. It is triangular, and usually touches both girdle and star (or table) facet. It does not increase brilliance over the regular type, indeed, it is probably not as effective. Its main advantage is that it can be placed on a stone of other than round outline, without effecting the girdle. Thus the facet can be used to increase brilliance over the simple step type.

TEN-SIDED STAR







PAVILION- five-fold symmetry, 40 index, using main and break settings.

1- cut five main facets (M) at culet angle, on five-fold asterisk settings.

2- ten break facets (B) at culet angle plus 7°, on break settings adjacent to step 1 settings.

3- ten girdle facets at 90°, on step 2 settings.

Suggested polishing order; 1-2, and two break facets (P), adjacent to a main (X).

The ten-sided star is suitable for low RI materials of a medium color.

CROWN- all facets are cut on main and break settings. Align stone with the point (X) to a main setting.

1- cut five main facets (M) at crown angle, on main settings at midpoint of the asterisk settings.

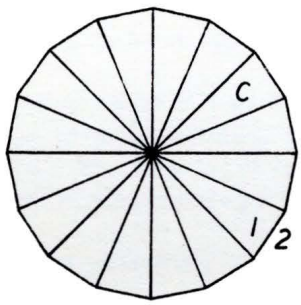
2- ten break facets (B) at crown angle plus 5°, on break settings adjacent to the asterisk settings.

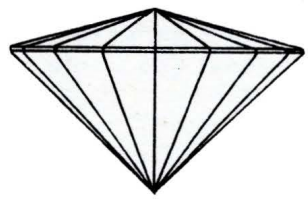
3- five star facets (S) at crown angle less 15°, on the asterisk settings.

4- cut the table (T) at 0°, to where it meets the junction of main and star facets.

Suggested polishing order; 4-3-1-2.

SPINNING WHEEL CUT





PAVILION- use any index, cutting any number of equidistant facets.

1- cut the desired number of culet facets (C) at culet angle.

2- a like number of girdle facets at 90°.

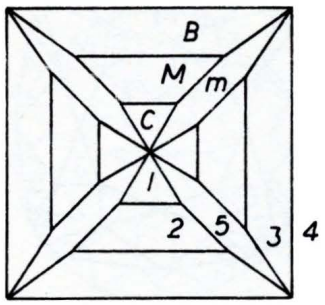
Polish; only the culet facets.

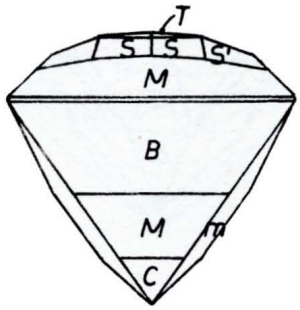
CROWN- align one of the girdle facets to any of the settings used for the pavilion. Polish the girdle.

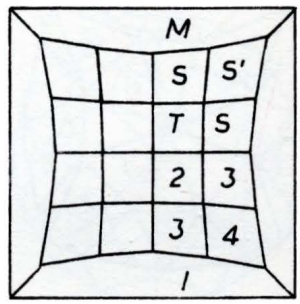
1- cut and polish an identical number of facets at 15°, or slightly less.

The spinning wheel cut returns an intriguing pattern with low RI materials.

CHECKER CUT







PAVILION- four-fold symmetry, 32 index, using asterisk main settings.

1- cut four culet facets (C) at culet angle, on alternate asterisk settings.

2- four main facets (M) at culet angle plus 10°, on step 1 settings.

3- four break facets (B) at culet angle plus 20°, on step 2 settings.

4- four girdle facets at 90°, on step 3 settings.

5- four main facets (m) at culet angle plus or minus 2°, on the balance of the asterisk settings.

Suggested polishing order; 1-2-3-5. Do not polish girdle.

CROWN- 32 index, using main and star settings. Align stone by indexing one of the girdle facets to the ID setting. Polish the girdle.

1- cut four main facets (M) at crown angle, on the settings used to polish the girdle.

2- four table facets (T) at 3°, on asterisk settings at midpoint of step 1 settings. These may be done with the 45° dop (at 48°) if desired.

3- eight star facets (S) at 6°, on star settings at midpoint of step 1 and 2 settings.

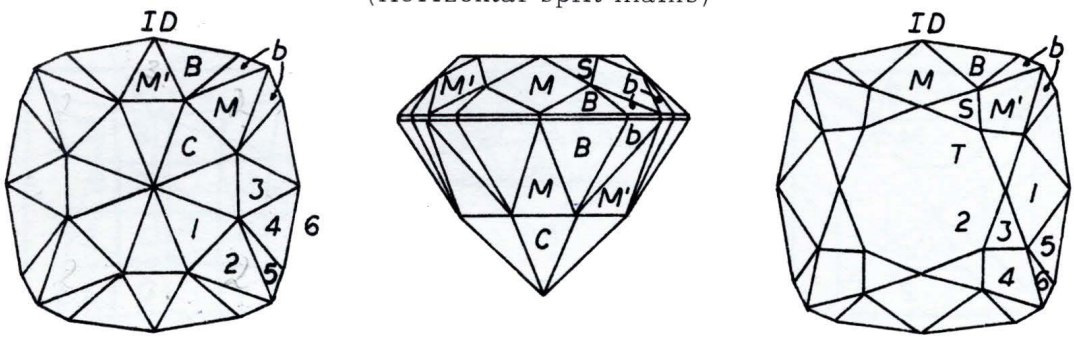
4- four star facets (S') at 8°, on step 2 settings.

Suggested polishing order; 2-3-1-4.

The checker cut is very interesting, and works well with low to medium RI materials. Almost any color hue is satisfactory.

SQUARE BRILLIANT

(Horizontal split mains)



PAVILION- eight-fold symmetry, 32 index, using all main and break settings.

1- eight culet facets (C) at culet angle, on eight-fold asterisk settings.

2- four corner main facets (M) at culet angle plus 5°, on alternate asterisk settings.

3- four side main facets (M') at culet angle plus 7°, on the remaining asterisk settings.

4- eight break facets (B) at culet angle plus 15°, on break settings adjacent to step 3 settings.

5- eight break facets (b) at culet angle plus approximately 15°, on break settings adjacent to step 2 settings.

6- sixteen girdle facets at 90°, on step 4 and 5 settings.

Suggested polishing order; 1 to 5. Do not polish girdle.

The horizontal split mains square brilliant is an excellent cut, returning a high amount of brilliance. It, and some closely related cuts, has been used with some of the world's largest diamonds. The cut will work well with almost any material if the color hue is not deep.

CROWN- all facets are cut on the settings used for the pavilion. Align stone by indexing one of the large side girdle facets to the correct break setting. The side main should be indexed to the ID setting. Polish the girdle facets on pavilion step 6 setting.

1- four side main facets (M) at crown angle, on alternate asterisk settings, beginning with the ID setting.

2- cut the table (T) at 0°, to where its width is 50% of the stone width.

3- eight star facets (S) at crown angle less 15°, on break settings adjacent to step 1 settings.

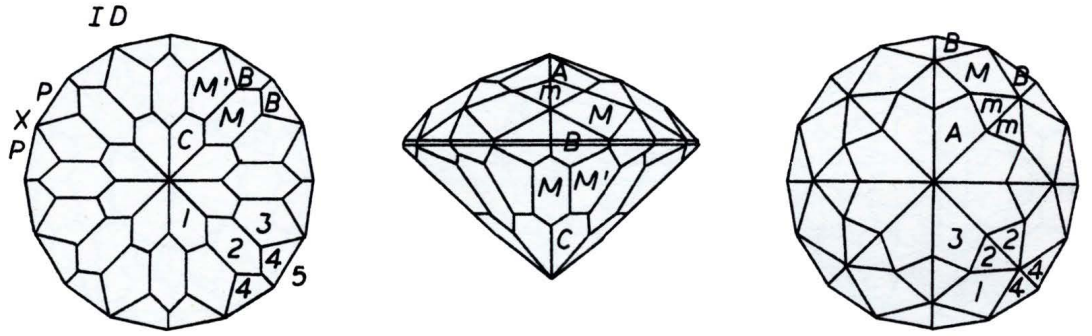
4- four corner main facets (M') at crown angle less 2° to 10°, on asterisk settings not used in step 1.

5- eight break facets (B) at crown angle plus 5° to 15°, on step 3 settings.

6- eight break facets (b) at crown angle plus 4° to 10°, on break settings adjacent to step 4 settings.

Suggested polishing order; 2-3-4-1-5-6.

JUBILEE CUT



PAVILION- eight-fold symmetry, 32 index, using all settings.

1- cut eight culet facets (C) at culet angle less 5°, on eight-fold asterisk settings.

2- eight main facets (M) at culet angle, on star settings at midpoint of step 1 settings.

3- eight main facets (M') at culet angle plus 3°, on step 1 settings.

4- sixteen break facets (B) at culet angle plus 4° to 7°, on all break settings.

5- sixteen girdle facets at 90°, on step 4 settings.

Suggested polishing order; 1-2-3-4, and two break facets (P), one to each side of a main (X).

CROWN- 32 index, using main and break settings. Align stone with the point (X), between the polished breaks (P), to a main setting.

1- cut eight main facets (M) at crown angle, on asterisk settings.

2- sixteen split main facets (m) at crown angle less 12°, on all break settings.

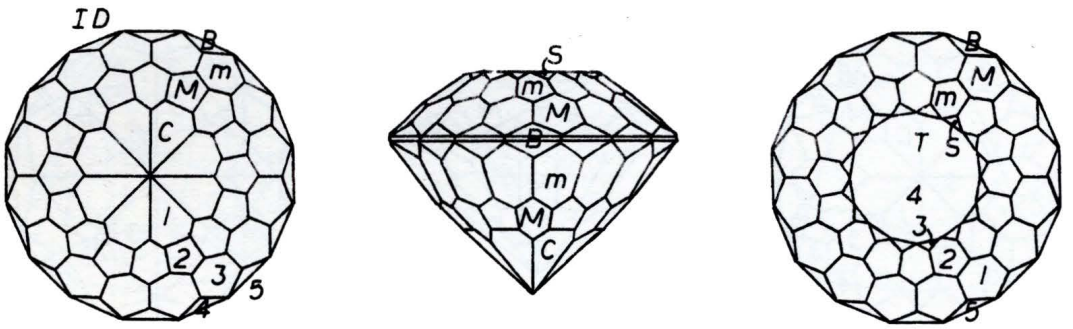
3- eight apex facets (A) at crown angle less 22°, on step 1 settings.

4- sixteen break facets (B) at crown angle plus 12° to 18°, on step 2 settings.

Suggested polishing order; 3-2-1-4.

The jubilee cut is excellent with low RI materials of medium color hue. In spite of a lack of a table and the low pavilion angle, it returns a remarkable amount of brilliance. The lack of a table allows the low pavilion angle. Because of the shallowness of the stone, it may be easily set in mountings designed for the standard brilliant.

HONEYCOMB CUT



PAVILION- eight-fold symmetry, 64 index, using all main and star settings.

1- cut eight culet facets (C) at culet angle, on the eight-fold asterisk main settings.

2- sixteen main facets (M) at culet angle plus 7°, on all main settings.

3- sixteen main facets (m) at culet angle plus 14°, on all star settings.

4- sixteen break facets (B) at culet angle plus 20°, on step 2 settings.

5- sixteen girdle facets at 90°, on step 4 settings.

Suggested polishing order; 1-2-3-4. Do not polish girdle.

The honeycomb cut was designed originally for much lower pavilion angles, but this will produce a "fisheye". The angles above result in facets that are not hexagonal as desired. The cut may be adapted to overcome this by making a stone such as the jubilee cut, and lowering all angles about 7° to 10°. The table is dispensed with by extending the star facets to an apex.

CROWN- 64 index, using all main and star settings. Align stone by indexing any girdle facet to any main setting. Polish the girdle.

1- cut sixteen main facets (M) at crown angle, on all star settings.

2- sixteen main facets (m) at crown angle less 7°, on all main settings.

3- sixteen star facets (S) at crown angle less 15°, on step 1 settings.

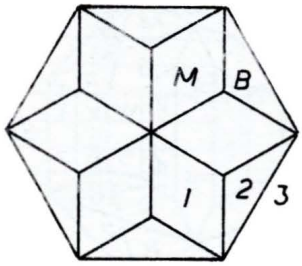
4- cut the table (T) at 0°, to the junction of the star facets.

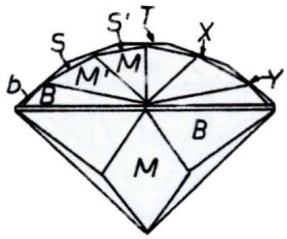
5- sixteen break facets (B) at crown angle plus 7°, on step 2 settings.

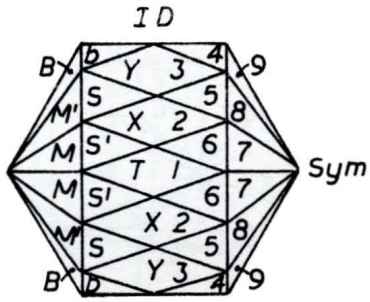
Suggested polishing order; 4-3-2-1-5.

Either form of this cut is excellent with low RI materials of medium color hue. The amount of returned brilliance is quite good.

DIAMOND BAR CUT







PAVILION- six-fold symmetry, 48 index, using main settings only.

1- cut six main facets (M) at culet angle, on non-asterisk main settings.

2- six break facets (B) at culet angle plus 13°, on asterisk settings.

3- six girdle facets at 90°, on step 2 settings.

Suggested polishing order; 1-2. Do not polish girdle.

This very unique cut, which won the 1961 O' Brien Trophy, was designed by LaVerna Coburn, Los Angeles, California. Cutting of this pattern calls for much use of the cheater, and there may be need for small angle adjustments on the crown.

The crown facets are given without any reference to the crown angle, in order to not disturb the precise relationship of the different types of facets. The cut is best used in a large stone with low RI medium hue materials.

When using the 45° dop to cut and polish the table and crown facets, the angles of the crown facets will be 55° and 65°.

CROWN- 48 index, using main, star, and break settings. Align stone with a girdle facet indexed to the ID setting. Polish the girdle.

1- cut the table facet (T) at 0°, on the ID setting.

2- two crown facets (X) at 10°, on ID setting and its opposite.

3- two crown facets (Y) at 20°, on step 2 settings.

4- four break facets (b) at 81°, on break settings adjacent to ID setting and its opposite.

5- four star facets (S) at 60°, on step 4 settings.

6- four star facets (S') at 43°, on step 5 settings.

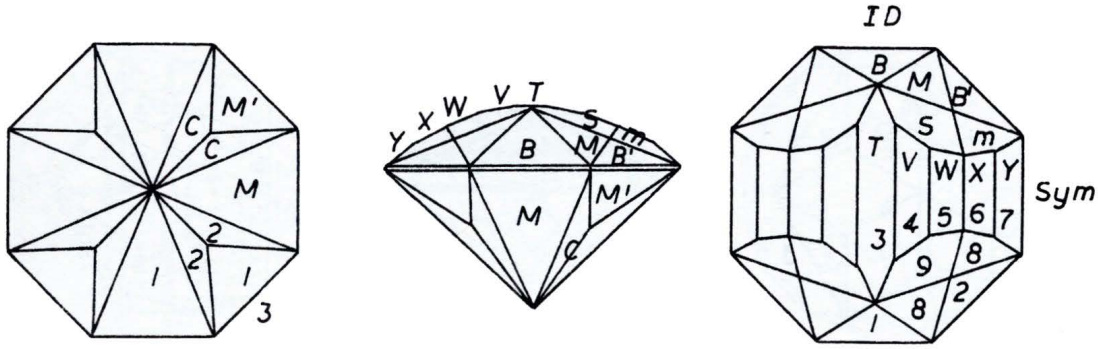
7- four main facets (M) at 43°, on star settings to each side of symmetry setting and its opposite.

8- four main facets (M') at 52°, on asterisk settings other than ID setting and its opposite.

9- four break facets (B) at 60°, on break settings adjacent to step 8 settings.

Suggested polishing order; 1-2-3-6-5-4-7-8-9.

EXOTIC CUT



PAVILION- eight-fold symmetry, 64 index, using main and break settings.

1- cut eight main facets (M) at culet angle plus 4°, on eight-fold asterisk main settings.

2- eight culet facets (C) at culet angle, on break settings adjacent to alternate asterisk settings.

3- eight girdle facets at 90°, on step 1 settings.

Suggested polishing order; 1-2. Do not polish the girdle.

This very unique cut was also designed by LaVerna Coburn. It is excellent with low RI materials, and best in large stones.

The execution of the cut calls for frequent use of the cheater, and there may be need for some angle changes.

When using the 45° dop to cut the crown facets, the angles will read 55°, 65°, 75°, and 85°.

CROWN- 64 index. Align stone by indexing any girdle facet to an asterisk setting. Polish the girdle.

1- cut two break facets (B) at crown angle less 9°, on ID setting and its opposite.

2- four break facets (B') at crown angle plus 9°, on alternate asterisk settings.

3- cut the table (T) at 0°, on symmetry setting.

4- two crown facets (V) at 10°, on symmetry setting and its opposite.

5- two crown facets (W) at 20°, on step 4 settings.

6- two crown facets (X) at 30°, on step 5 settings.

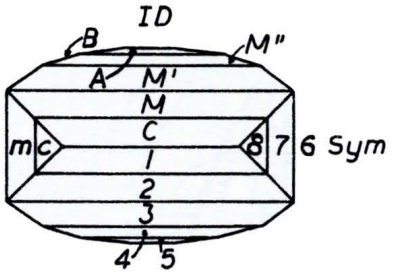
7- two crown facets (Y) at 40°, on step 6 settings.

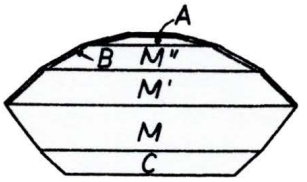
8- eight main facets (M&m) at crown angle less 1° to 10°, on alternate star settings.

9- four star facets (S) at crown angle less 10° to 16°, on step 2 settings.

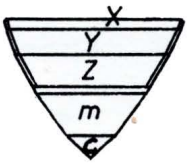
Suggested polishing order; 3-4-5-6-7-9-8-2-1.

OPPOSED BAR CUT

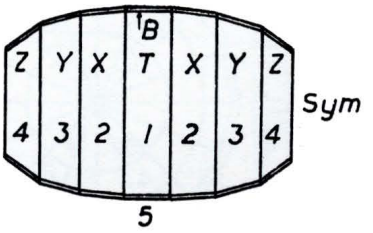




Side View



End View



PAVILION- four-fold symmetry, 32 index, using alternate asterisk settings.

1- cut two culet facets (C) at culet angle, on ID setting and its opposite.

2- two main facets (M) at culet angle plus 8°, on step 1 settings.

3- two main facets (M') at culet angle plus 16°, on step 2 settings.

4- two main facets (M") at culet angle plus 24°, on step 3 settings.

5- two apex facets (A) at culet angle plus 32°, on step 4 settings.

6- two girdle facets at 90°, on symmetry setting and its opposite.

7- two end main facets (m) at culet angle plus 8°, on step 6 settings.

8- two end culet facets (c) at culet angle, on step 7 settings.

Suggested polishing order; 1-8-2-7-3-4-5. Do not polish the two girdle facets.

CROWN- all facets are cut on symmetry setting and its opposite. Align stone by indexing one of the girdle facets to the symmetry setting. Polish the two girdle facets.

1- cut the table facet (T) at 0°, on symmetry setting.

2-two crown facets (X) at 15°, on symmetry setting and its opposite.

3- two crown facets (Y) at 30°, on step 2 settings.

4- two crown facets (Z) at 45°, on step 3 settings.

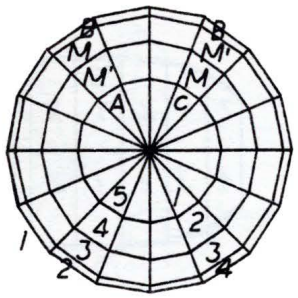
5- fourteen small break facets (B) on the ends of facets T, X, Y, and Z at approximately 30°, on ID setting and its opposite and the adjacent settings. These facets remove the sharp edge of the crown.

Suggested polishing order; 1 to 5.

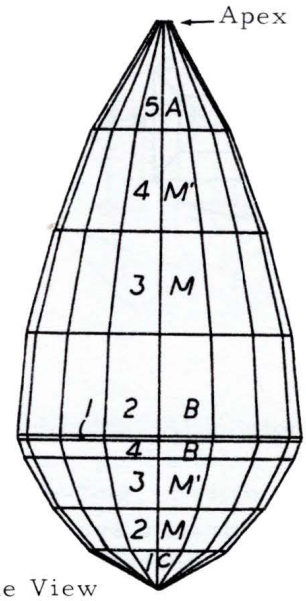
This spectacular cut was designed by Gustave Mollin, of Oakland, Calif. The cut is excellent in smoky quartz, light amethyst, or other medium hue material. A length of about 20 millimeters or larger is best.

STEP BRIOLETTE

Upper Lower



Axis View



Side View

UPPER PORTION- sixteen-fold symmetry, 32 index, using main and star settings.

1- cut sixteen girdle facets at 90°.

2- sixteen break facets (B) at 85°.

3- sixteen main facets (M) at 77°.

4- sixteen main facets (M') at 70°.

5- sixteen apex facets (A) at 60°.

Suggested polishing order; 5-4-3-2. Do not polish girdle.

This cut is very similar to the round step cut and the step rose. It is easy to execute. All angles may be changed to suit the preform at hand. All facet heights may also be altered if it is advantageous in order to create a good curve. The break facet of the lower portion is shown small, which could be the result of insufficient material. Where there is ample, the break may be larger.

LOWER PORTION- all facets are cut on the same settings as their counterparts on the upper portion. Align stone by indexing a girdle facet to one of the settings used for the upper portion. Polish the girdle.

1- cut sixteen culet facets (c) at 30°.

2- sixteen main facets (M) at 50°.

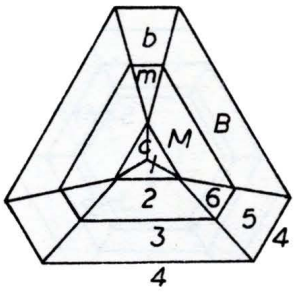
3- sixteen main facets (M') at 60°.

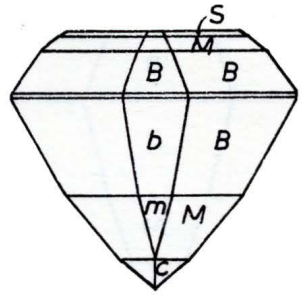
4- sixteen break facets (B) at 70°.

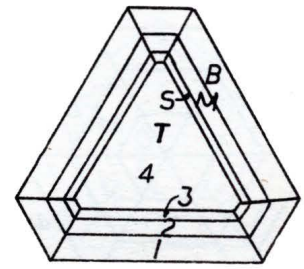
Suggested polishing order; 1-2-3-4.

The use of this cut with smoky quartz or light amethyst, and fashioned into a pendant, produces a very satisfactory piece of jewelry.

THE TRIANGLE





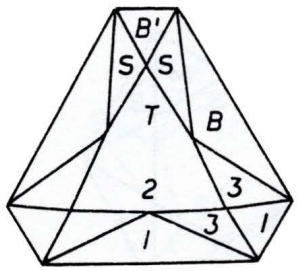


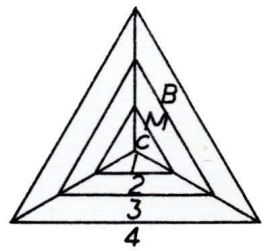
Cut-corner Triangle

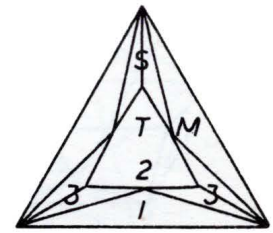
PAVILION- three-fold symmetry, 48 index, with simple step cut angles. The first set of facets is cut on alternate six-fold asterisk settings; the second set is cut on ID setting and the balance of the asterisk settings.

CROWN- using the same settings as the pavilion, with simple step cut angles.

The step triangle pavilion, center below, is cut on alternate asterisk main settings only, using simple step cut angles.







Cut-corner Cardinal

Step Triangle

Cardinal Triangle

CROWN- 48 index, pavilion above, using main and star settings. Align stone with a short girdle facet aligned to the ID setting.

1- cut six break facets (B& B') at crown angle, on asterisk settings.

2- cut the table (T) at 0°, to where its width is about 50% of the stone width, and to where it touches break facets (B').

3- six star facets (S) at crown angle less 13° to 17°, on star settings adjacent to step 1 settings.

Suggested polishing order; 3-2-1.

CROWN- 48 index, pavilion at left, using only three alternate asterisk settings, and adjacent star settings.

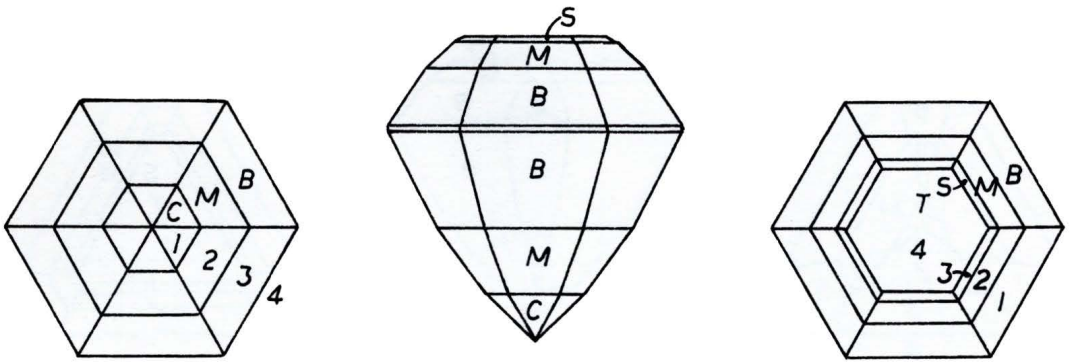
1- cut three main facets (M) at crown angle, on alternate asterisk settings.

2- cut the table (T) at 0°, to where its width is about 50% of the stone width.

3- six star facets (S) at crown angle less 15° to 20°, on star settings adjacent to step 1 settings.

Suggested polishing order; 3-2-1.

THE HEXAGON

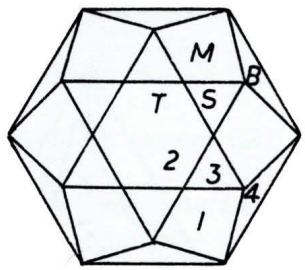


Hexagonal Step Cut

PAVILION- six-fold symmetry, 48 index, using simple step cut angles, and indexing on the six-fold asterisk main settings. Cut according to the numbered sequence, polish in reverse order.

CROWN- all facets are cut on the same settings as for the pavilion, using simple step cut crown angles.

The hexagonal step cut is good only with the medium hue, low RI materials. The combination of the step pavilion with a mixed crown is a much better choice.



Mixed Hexagon

CROWN- 48 index, using main and star settings. Align stone by polishing the girdle on asterisk settings.

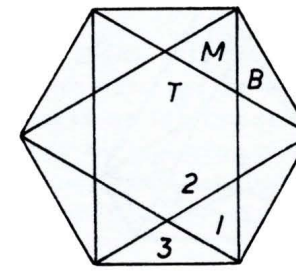
1- six main facets (M) at crown angle, on non-asterisk main settings.

2- cut the table (T) at 0°, to where its width is about 50% of the stone width.

3- six star facets (S) at crown angle less 15°, on asterisk settings.

4- six break facets (B) at crown angle plus 5° to 20°, on step 3 settings.

Suggested polishing order; 2-3-1-4.



Simple Mixed Hexagon

CROWN- 48 index, using main and star settings. Align stone by polishing girdle on asterisk settings.

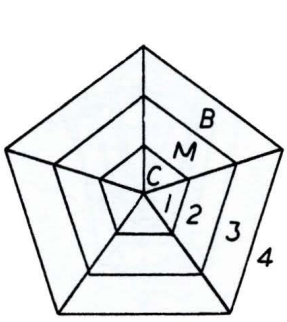
1- cut six main facets (M) at crown angle, on non-asterisk main settings.

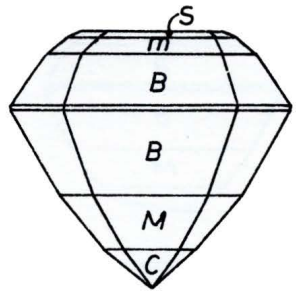
2- cut the table (T) at 0°, to where its width is about 50% of the stone width.

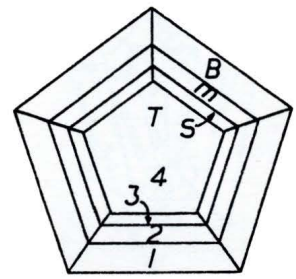
3- six break facets (B) at crown angle plus 8° to 15°, on the asterisk main settings.

Suggested polishing order; 2-1-3.

THE PENTAGON





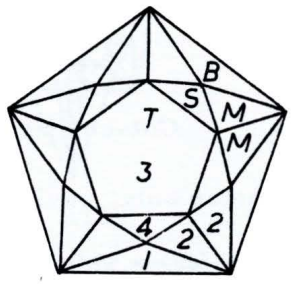


Step Pentagon

PAVILION- five-fold symmetry, 40 index, using non-asterisk main settings. The angles are those of the simple step cut. Cut according to the numbered sequence, polish in reverse order.

CROWN- all facets are cut on the settings used for the pavilion, using simple step cut crown angles.

The pentagon step cut offers an interesting play of light at the corners, but should be used only with low RI materials. The step pavilion in combination with either mixed crown gives better results.



Mixed Pentagon

CROWN- 40 index, using main and break settings.

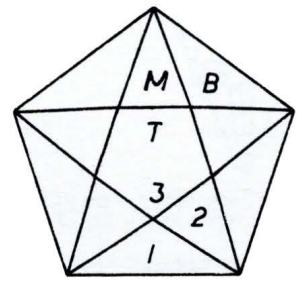
1- cut five break facets (B) at crown angle, on non-asterisk main settings.

2- ten main facets (M) at crown angle less 7°, on break settings adjacent to step 1 settings.

3- cut the table (T) at 0°, to where its width is 50% of the stone width.

4- five star facets (S) at crown angle less 15° to 20°, on step 1 settings.

Suggested polishing order; 3-4-2-1.



Simple Mixed Pentagon

CROWN- 40 index, using main settings only.

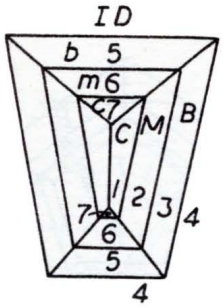
1- cut five break facets (B) at crown angle, on non-asterisk main settings.

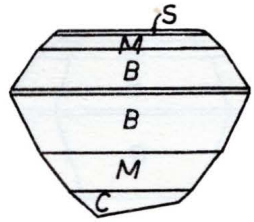
2- five main facets (M) at crown angle less 17°, on asterisk settings.

3- cut the table (T) at 0°, to the junction of break and main facets.

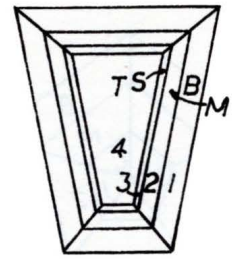
Suggested polishing order; 3-2-1.

THE KEYSTONE





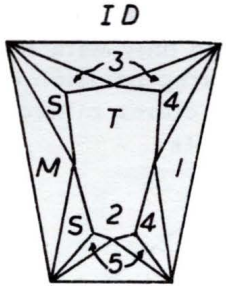
Step Keystone



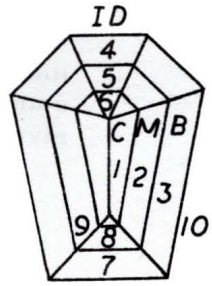
PAVILION- four-fold symmetry, 32 index, using angles of the simple step cut. The sides are cut on a break setting, adjacent to symmetry setting and its opposite. Cut with the numbered sequence, polish in reverse order

CROWN- use simple step cut angles and the settings used for pavilion.

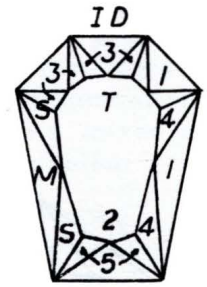
The keystone step cut is best used with low RI materials of dark or medium hue. The cardinal crowns make a better combination.



Cardinal Keystone



Cut-corner Step Keystone



Cut-corner Cardinal

CROWN-96 index only, pavilion above.

1- cut four main facets (M) at crown angle, on settings used for pavilion.

2- cut the table (T) at 0°, to where its width is 50% of the stone width.

3- two star facets (S) at crown angle less 4° to 8°, on break settings adjacent to the ID setting.

4- four star facets at crown angle less 5° to 9°, on settings adjacent to the side main setting.

5- two star facets at crown angle less 2° to 6°, on break settings adjacent to the opposite of ID setting.

Suggested polishing order; 5-4-3-2-1.

PAVILION- lower center, indexing as upper left, plus two asterisk settings.

CROWN- 96 index only, pavilion at left.

1- cut six main facets (M) at crown angle, on settings used for pavilion.

2- cut the table (T) at 0°, to where its width is 50% of the stone width.

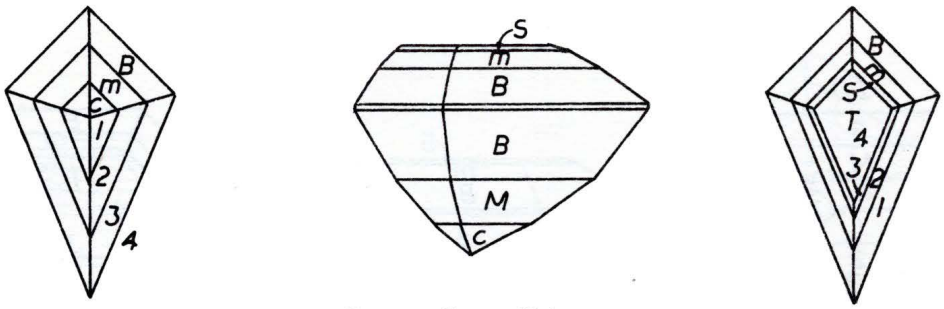
3- six star facets (S) at crown angle less 2° to 5°, on break settings adjacent to the ID setting, and on the adjacent asterisk settings.

4- four star facets at crown angle less 2° to 6°, on settings adjacent to the side main settings.

5- two star facets at crown angle less 2° to 5°, on break settings adjacent to the opposite of the ID setting.

Suggested polishing order; 5-4-3-2-1.

THE KITE

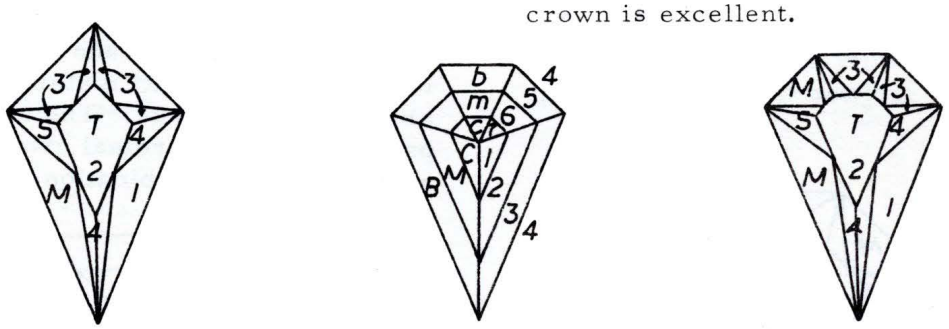


Step Cut Kite

PAVILION- four-fold symmetry, 32 index, using simple step cut angles; indexing on asterisk settings adjacent to ID setting, and star settings adjacent to symmetry setting and its opposite.

CROWN- use the same settings as the pavilion, with simple crown angles.

The step cut kite is good with most materials, and returns a surprising amount of brilliance. The step cut pavilion combined with a cardinal crown is excellent.



Cardinal Kite Cut-corner Kite Cut-corner Cardinal

CROWN-96 index only, pavilion above.

1- cut four main facets (M) at crown angle, on pavilion girdle settings.

2- cut the table (T) at 0°, to where, its width is 50% of the stone width.

3- four star facets (S) at crown angle less 6° to 12°, on star settings adjacent to the asterisk settings.

4- four star facets at crown angle less 6° to 12°, on settings adjacent to the lower main settings.

Suggested polishing order; 2-3-4-1.

The cut-corner pavilion, lower center, uses the angles above with addition of facets cut on the ID setting.

CROWN- 96 index only, pavilion at left.

1- five main facets (M) at crown angle, on the pavilion girdle settings.

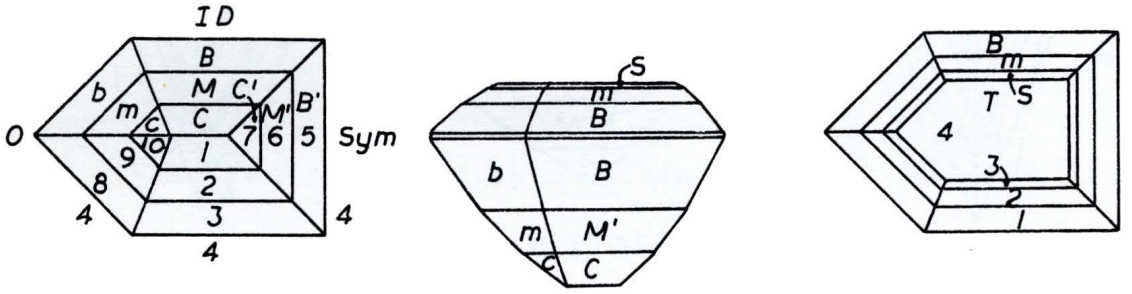
2- cut the table (T) at 0°, to where its width is 50% of the stone width.

3- six star facets (S) at crown angle less 2° to 8°, on star settings adjacent to ID setting and the adjacent asterisk settings.

4- four star facets at crown angle less 6° to 12°, on settings adjacent to the lower main settings.

Suggested polishing order; 2-3-4-1.

THE OBUS

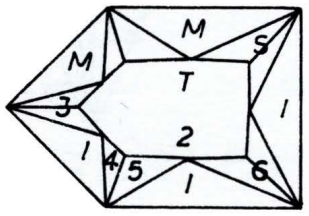


Step Obus

PAVILION- 32 index, using the angles of the simple step cut, and indexing similarly, with the exception that one end is cut to a point (O) by indexing on asterisk main settings adjacent to the opposite of the symmetry setting.

CROWN- indexed on the same settings of the pavilion, using angles of the simple step cut crown.

The step obus returns a surprising amount of brilliance, and is suitable for low to medium RI materials in almost any color hue. The step pavilion and the cardinal crown is an even better combination.

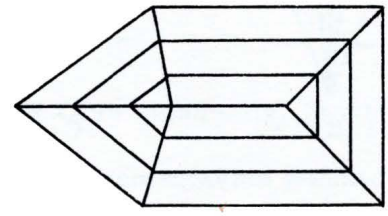


Cardinal Obus

CROWN- 64 or 96 index. This is quite variable for angles and settings of the star facets. The length of the stone in relation to width, and the angle of the pointed end will have great bearing on them. Ordinarily, the star facets may be cut on star or break settings adjacent to those used for the main facets. The star angles will usually be between 5° and 15° less than the crown angle.

Follow the numbered sequence for cutting.

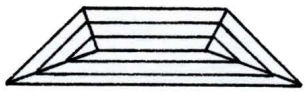
Suggested polishing order; table, stars, mains.



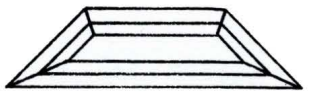
Acute Obus

PAVILION- the above pavilion is nearly identical to the one at upper left, with the exception that the pointed end is indexed on other than asterisk settings. This allows a large amount of latitude for varying this cut.

MISCELLANEOUS STEP CUTS



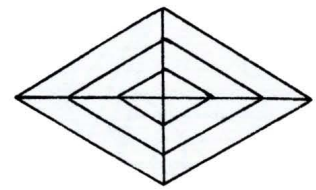
Pavilion



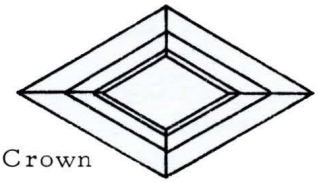
Crown

Trapeze Cut

32 index, using ID setting and its opposite, and asterisk main settings adjacent to ID setting.



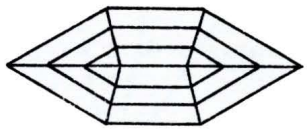
Pavilion



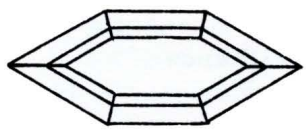
Crown

Lozenge Cut

48 index, using ID setting and its opposite, and asterisk main settings adjacent to ID setting.



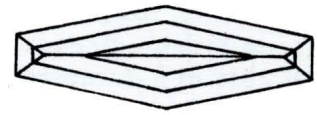
Pavilion



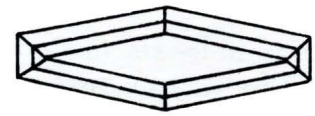
Crown

Navette Cut

48 index, using ID setting and its opposite, and asterisk settings adjacent to them.



Pavilion

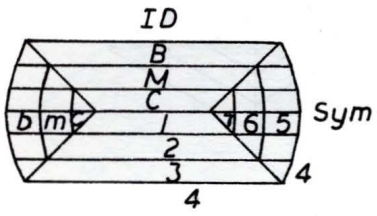


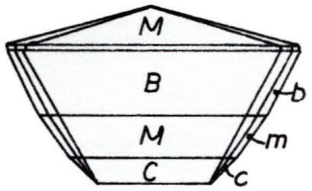
Crown

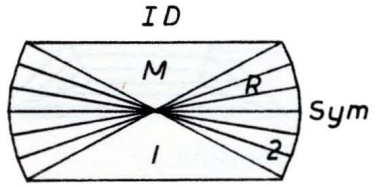
Double Taper Cut

32 index, using break settings adjacent to ID setting and its opposite; and symmetry setting and its opposite.

RADIAN CUT







PAVILION- 32 index, using ID setting and its opposite, and a group of settings adjacent to symmetry setting and its opposite.

1- two culet facets (C) at culet angle, on ID setting and its opposite.

2- two main facets (M) at culet angle plus 10°, on step 1 settings.

3- two break facets (B) at culet angle plus 20°, on step 2 settings.

4- two girdle facets at 90°, on step 3 settings; and twelve girdle facets at 90°, on three adjacent settings to each side of symmetry setting and its opposite.

5- twelve break facets (b) at culet angle plus 20°, on the second group of step 4 settings.

6- eight main facets (m) at culet angle plus 10°, on part of step 5 settings.

7- two culet facets (c) at culet angle, on settings adjacent to symmetry setting and its opposite.

Suggested polishing order; 1-7-2-6-3-5. Do not polish the girdle.

CROWN- 32 index, using the settings of the pavilion. Align stone by indexing one of the long girdle facets to the ID setting. Polish the girdle.

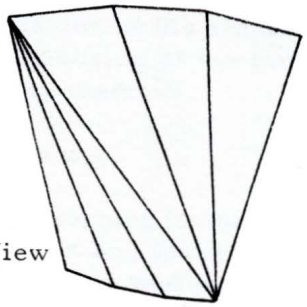
1- cut two main facets (M) at crown angle, on ID setting and its opposite.

2- twelve radiating facets (R) at the angle necessary to reach from center to edge. The most optimum angle is between 10° and 20°, and it will depend upon the length to width relationship of the stone. Indexing for these facets is the same as was used for the end girdle facets.

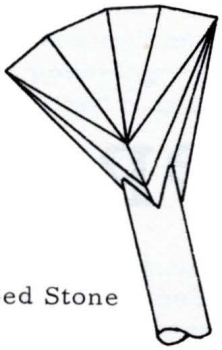
Suggested polishing order; 1-2.

The radian cut is best used with low RI materials of light to dark color hue. The cut returns a good amount of brilliance.

FAN CUT



Projected View

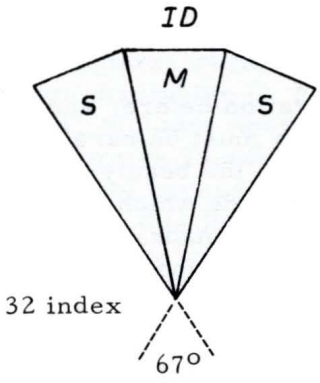


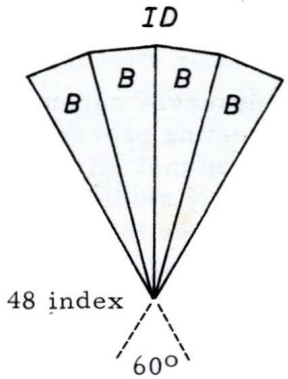
Dopped Stone

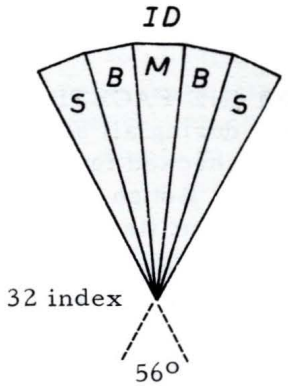
View above - 32 index, using ID setting, and adjacent star settings. The protractor setting is 67° for the main setting. If necessary to insure perfect symmetry, the angle may be changed for the star settings.

Cut three facets on one side, and at the same settings, cut three identical facets of the opposite side. Polish in the same manner. Redop stone and repeat above sequence.

The projected view shows a completed stone, consisting of four triangles combined to form a double wedge. Each of the triangles is divided into three or more triangles, giving a curved line to the sharp edges. The preform should be a double "axe" shape. The dopped stone is shown above.







The fan cut is easy to execute, if care is taken to insure perfect symmetry during all stages. It will be satisfactory with almost any type of material, and in any but the dark color hues.

The basic pattern may be varied as shown below. Other variations should be evident.

View left - 48 index, using two break settings on each side of the ID setting. Cut the two central facets at 60°, changing the angle for the outer pair if needed. Repeat for the second face. Redop and cut and polish the second set.

View above - 32 index, using ID setting and break and star settings to each side. Cut the central main facets at 56°, changing the angle for the break and star settings if necessary.

Chapter IX

Preparing For Faceting

FINE FACETING ROUGH deserves careful consideration before, and during all stages of the faceting process. All rough must be carefully checked for any imperfection that might detract from the beauty of the final gem. Rough should be thoroughly studied in order to decide which cut will best bring out its inherent beauty. After this decision has been made, the piece of rough should then be formed as closely as possible to the final shape of the finished gem. This results in what is known as a preform. There are a number of faceters who place a rough piece of material onto a dop stick and proceed to cut a gem. They do produce a gem, but there is little doubt that this method is either wasteful, or that a number of adjustments are necessary before the cutting starts in earnest.

Preforming removes all unwanted surface imperfections, and if necessary, all internal imperfections slightly below the surface. A preform, if well done, can be aligned perfectly on the dop stick, and thus will remove many possibilities for error. The best argument for preforming concerns surface cracks. If they are allowed to remain on the dopped stone, they may, with subsequent cutting, enlarge and move into the gem. This may also happen during the grinding of preforms, but at this stage the flaws may be pursued and removed. Any changes during preforming may need only small readjustments of shape and size. Without first being preformed the stone may need to be redopped and the process started a second time.

MAKING THE PREFORM

There are a number of steps to the making of a preform. The first is to carefully study the piece of rough to determine the existence of any factors that will affect the behavior of the stone during cutting and polishing. This study should result in the choosing of the final shape of the gem, and may be done according to the following methods.

Finding Flaws

The most important feature of a gem is flawlessness. A flawed gem is of a lesser value than one that is flawless, but it is sometimes necessary to attempt to cut gems from flawed material. If the flaw or flaws are near the center of the piece, and their removal would greatly reduce the size of the finished gem, it might be wise to let them remain. If the flaw is to one side of the piece of rough, it may be hidden under the break facets. It follows that the faceter must be certain whether or not there are flaws, and if so, their exact location. It also follows, that if the flaw is in the center of the piece, it would make a poor gem, and might be best not cut. Indeed, it would be far better not to purchase such material.

Using Immersion Liquids

The simplest and most effective way to see any inclusions is by immersion in some liquid with a refractive index more or less matching the refractive index of the rough. Table 11 lists a number of common liquids, their refractive index, and their generally effective range. Each will work well for the range indicated. Some will perform well over a wider range. Nearly all have the drawback that they are odorous, and the liquids with the higher indices are costly.

For general work among minerals with a refractive index up to about 1.85, carbon disulphide (R.I. 1.64) will do nicely. It is quite odorous, but unlike most others, the odor does not linger on the rough, instruments, hands, or clothing. It evaporates rapidly, and is flammable. If the container, as shown in Figure 70, is kept covered as much as possible, and some reasonable fire precautions observed, this liquid is satisfactory. If the faceter would rather not use this liquid, acetylene tetrabromide is a good substitute.

Either of these liquids has the advantage that it will work satisfactorily with the materials with indices from 1.40 to 1.59; very well with those from 1.60 to 1.75; and satisfactorily from 1.76 to 1.85. As most gems fall within these limits, seldom would another liquid be necessary. For the rare occasions that the faceter will have rough of a higher refractive index, he can keep on hand a small amount of methylene iodide. If kept tightly closed and away from strong light, the higher index liquids do not deteriorate. With infrequent use, a small supply should last many years.

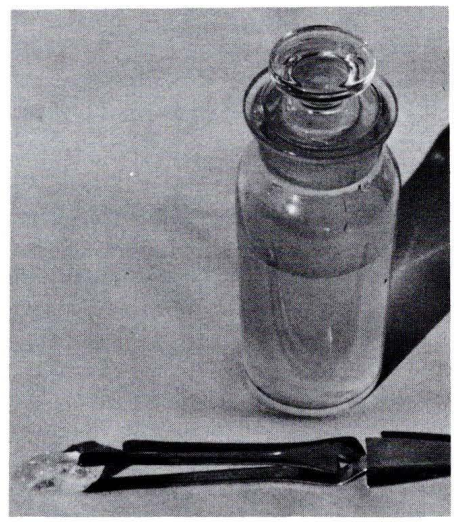


Figure 70. Immersion Equipment.

TABLE 11

LIQUIDS FOR REFRACTIVE INDEX IMMERSION
AND SPECIFIC GRAVITY DETERMINATIONS

Liquid	R. I.	General Range (See table 8)	Sp. Gr.	Diluent
Water	1.33		1.0	
Glycerine	1.47	1.4 to 1.56 fluorite to beryl	1.26	water
Ethylene bromide	1.53	1.4 to 1.6 fluorite to beryl	2.17	alcohol
Refractol*	1.56	1.4 to 1.62 fluorite to topaz	---	acetone
Anisaldehyde	1.57	1.4 to 1.6 fluorite to topaz	---	alcohol
Cinnamon oil (Cassia oil)	1.59	1.5 to 1.7 quartz to topaz	---	alcohol
Bromoform	1.59	1.5 to 1.7 quartz to zoisite	2.90	toluol
Quinoline	1.62	1.5 to 1.8 quartz to demantoid	---	alcohol
Carbon disulfide	1.63	1.5 to 1.8 quartz to demantoid	---	evaporates
Acetylene tetrabromide	1.63	1.5 to 1.8 quartz to demantoid	2.95	toluol
Bromonapthalene	1.65	1.5 to 1.8 quartz to demantoid	1.48	alcohol
Methylene iodide	1.74	1.6 to 2.0 topaz to zircon	3.32	toluol

One or two of the above liquids should be satisfactory for the uses of the average faceter. Other liquids may be found in the literature.[1] Many of the above liquids will do for specific gravity determinations as well as for R. I. immersion. For specific gravity work, they may be diluted to a number of densities if desired. The diluent may be used to clean the rough and the instruments used. Most of these liquids are somewhat odorous, but not repulsively so. Reasonable fire precautions should be observed with carbon disulfide. Methyline iodide is the the most useful of all the liquids, but is quite costly.

[1]See Gemologists Compendium, Webster - pg. 134

* Commercial products presently offered to the faceter.

To be used effectively, immersion liquids should be in a jar with a mouth wide enough to accept the largest piece of rough normally checked. A screw lid or ground glass stopper to hold down evaporation is necessary. To handle the rough when in the liquid, one will find indispensable a pair of self locking tongs, such as the jewelry makers soldering tongs shown in Figure 70.

The jar of liquid should be illuminated with a bright light. The light need not

be large. Small intense lights such as microscope sub-stage lights, or the "high intensity" lamps are excellent. A flashlight will work if nothing else is available. The important thing is that a bright light must be transmitted through the liquid toward the operator. The whole jar need not be illuminated, as long as there is a bright spot in or near the center of the jar. A small amount of light is far better than too much.

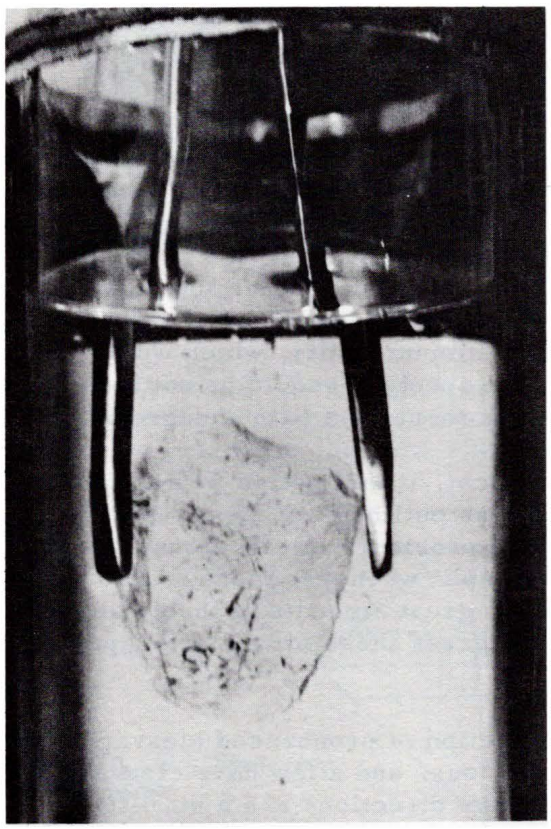


Figure 71. Flawed Rough in an Immersion Liquid.

The piece of rough is grasped with the tongs and lowered into the liquid as in Figure 71. If it is very near the same refractive index as the liquid, its outlines will become barely discernable, or may disappear. Any cracks or other inclusions will at the same time be accentuated. All flaws can be detected by careful turning and viewing of the rough from all angles. Careful noting of the size and location of any flaws will assist in the preliminary plans for layout of the future gem.

If the rough can be easily removed from the liquid and some type of mark be made in the vicinity of the flaws, the piece may be carefully mapped. It is necessary that the mark not be soluble in the liquid being used. For carbon disulphide the common water soluble felt point marking pen is excellent. This pen should work nicely with most liquids on Table 11. With an insoluble mark on the surface, the rough may again be lowered into the liquid for further examination.

When the rough has a different R.I. from the liquid, say 1.55 in one of 1.64, it will not tend to disappear, and its outlines may easily be seen. It will nevertheless become very transparent, and all flaws and inclusions may readily be seen.

Noting Cleavage And Twinning Planes

If a mineral has a pronounced cleavage plane, it may need to be correctly oriented so that no facet lies parallel to it. In the case of minerals with more than one cleavage, it is imperative that no plane lies parallel to the table. The species descriptions, in Appendix I, note the minerals that have one or more troublesome cleavages.

If we use topaz as an example, it will be found to have one pronounced cleavage that lies parallel to the base of the crystal. If the rough is not a crystal, the cleavage plane may be recognized from the flat face or faces to be found on one or opposite sides. On occasion the cleavage plane will show only as a few very small, but flat and brilliant faces. This is especially true of waterworn nodules.

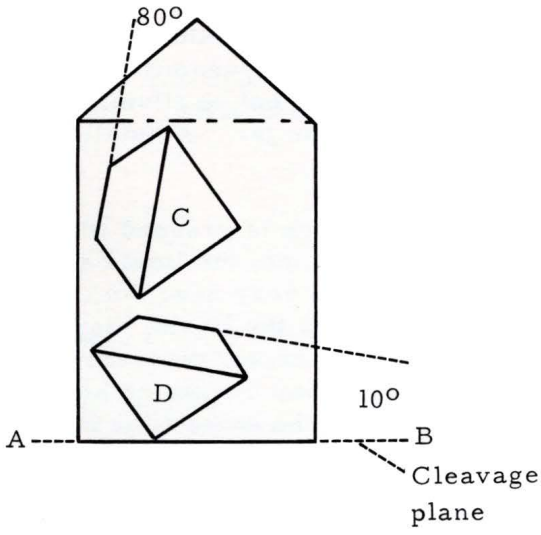


Figure 72. Orienting a Cleavage Plane.

As shown in Figure 72, the plane (A-B) must be oriented so that it lies about ten or eighty degrees away from the table. The greater degree orientation (depicted by stone C) is not as desirable as the lesser (as in stone D), as it places the cleavage plane almost directly across the table. Under these conditions, the gem may split with a hard blow on the crown. The ten degree slope of the cleavage plane is not absolute, and may be adjusted a small amount either way. If the figure is raised to twenty degrees or better, it will come close to the star facets which are usually cut about twenty five degrees. If the arc is much smaller, it will approach too closely to that of the table which is zero degrees. The maximum limits, which would fit all gem species, should be not less than five, or more than fifteen degrees.

If the cleavage plane is nearly parallel to a facet, it will polish with difficulty (or not at all), and will need special treatment as outlined in Chapter XI. It is possible that cutting will also be difficult. The problem centers around the fact that any easily developed cleavage will tend to split whenever there is a force striking parallel to it. In cutting and polishing, great amounts of thrust and heat are developed. At an angle of less than five degrees these forces are capable of opening a cleavage plane.

Some gem materials have more than one direction of pronounced cleavage. Many have two directions, some three, others four, and a few have cleavage in six directions. Those with two or three cleavage directions are a bit difficult to orient, but careful planning will place most facets at some midpoint between them. The materials with four or more directions are very difficult to orient without one or more facets lying on a cleavage plane. Here one should make the greatest effort to be certain that no cleavage is parallel to the table, and not be too concerned about other facets.

The table is the largest facet on a gem, and is the most noticeable. It often gives trouble in polishing simply because of its size, and it is important that a cleavage plane not be added to compound an inherent problem.

Twinning Planes

A few gem minerals appear as twins as shown in Figure 73. The v-notch in each specimen is known as the re-entrant angle; the bottom of the notch is the twinning plane. This is the line of contact of the two crystals that make up the twin. The twinning plane is a problem that sometimes confronts the faceter. The plane is weak and the gem may split along it. This splitting may occur at any time during the cutting and polishing process. In other cases, the twinning plane may disturb the passage of light. Some of them will refract light unless it strikes at normal, while others may scatter the light so that the brilliance of the gem will be affected. Any unusual problems for any gem mineral are noted in the species descriptions.

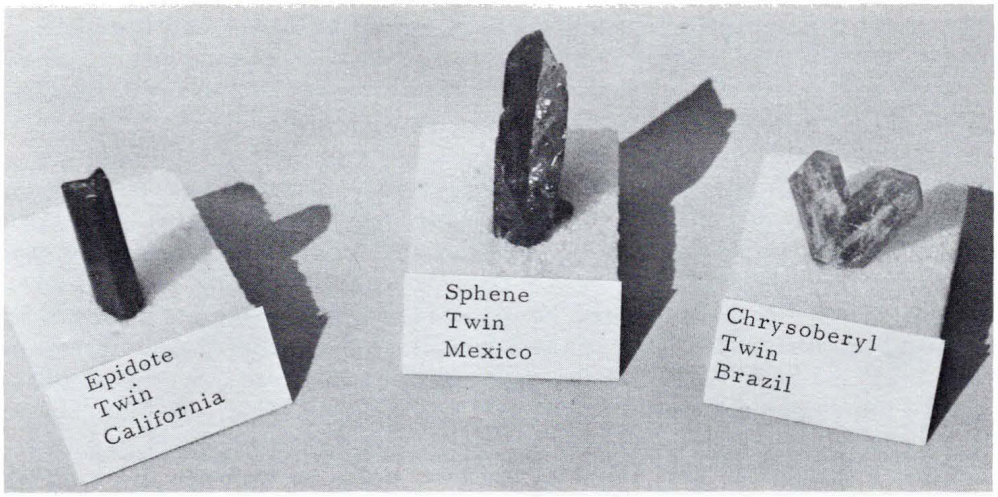


Figure 73. Some Twinned Crystals.

A general rule for twinning plane orientation might be stated. In most cases if the plane is placed parallel to the table and slightly below the girdle, it will give the least trouble. This is illustrated in Figure 74.

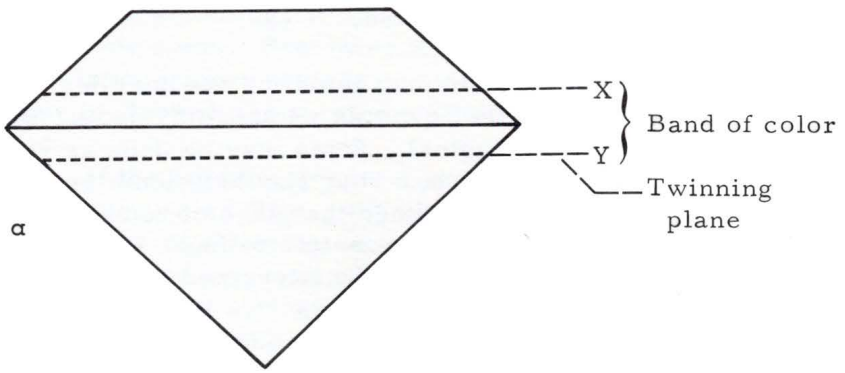


Figure 74.
Orienting a Color Band or a Twinning Plane.

Orientation For Color

Any color that is not the same intensity throughout the piece of rough must be taken into account in choosing the shape of the gem. Generally this situation is of two types. First, either spots or bands of color that are of a different shade or intensity from the balance of the piece; and second, a mineral that exhibits a distinct pleochroism. The first of these may be either handled as in Figure 37, Page 52, by placing the spot near the culet, or as in Figure 74 by placing the band of color parallel to the girdle between lines x and y. Either of these treatments will cause the whole stone to take on the deeper color.

Pleochroism

The handling of pleochroism varies greatly between species. In tourmaline, which is dichroic, especially in the greens and reds, there is little or no light passed through the long axis of the crystal. That which may be passed is muddy or fuzzy. Most color hues of tourmaline (the pinks and light blues excepted) should always be oriented as shown in Figure 49, Page 67. It is seldom

advisable to cut a deep hued tourmaline as a round brilliant, as the gem may appear to be dark on two sides with a lighter streak between them. The rectangular cuts with the long horizontal axis of the gem parallel to the long axis of the crystal give the best orientation.

The total absorption of light through the long axis of a dark green tourmaline crystal results in an interesting problem when it is cut into a rectangular stone. Any light that might enter the end of the gem and traverse its length is completely absorbed, resulting in the gem being practically black on the ends. This may be remedied by cutting the end pavilion facets at a very steep angle with the steps no more than five degrees apart. It will be virtually impossible to mount it in a commercial mounting, but the treatment should not interfere with setting the gem into handwrought jewelry.

In spodumene (hiddenite and kunzite) the best color is through the long axis of the crystal, and unlike tourmaline, the table is now placed at nearly right angles to it. Spodumene exhibits a very pronounced cleavage parallel to the long axis, and the table should be oriented 80 or 100 degrees away from it, as shown in Figure 72.

Andalusite presents interesting trichroism. Its colors are a light green, pinkish orange, and yellow. The yellow is difficult to see. If the crystal is oriented with the table of a step cut stone parallel to the long axis with the greenish color seen through the table, the resultant gem will appear greenish in the center and pink on the ends.

Some general rules can be presented for the handling of pleochroic materials. First, they should usually be cut as rectangular gems, with some form of the step cut being the most logical. Some may be done as round brilliants, but this is usually not the best choice. They should seldom be done as ovals unless special effects are desired. Second, the piece of rough should always be oriented so that the table is as close as possible to right angles to the direction of the most pleasing color. Care must be exercised to be sure that the color chosen is the best one. Immersion in a refractive index liquid is helpful. The correct handling of pleochroic minerals will produce outstanding gems. Incorrect orientation can produce displeasing stones.

Dictations Of The Shape Of The Rough

Shape will have the greatest bearing on the type of cut and its size. Most pieces of rough are irregular enough in shape that they may be turned in two or more directions, each of which might make a desirable gem. If one of these directions will correspond to directions resulting from the deliberations outlined above, the problem is small. If this is not true then something must be sacrificed, and the better (though most distasteful) choice is to sacrifice size.

It is very unusual that any piece of rough will embody all or most of the characteristics noted above, and the final choice is usually not a difficult one. Orienting a piece of faceting rough that would exhibit most of the above characters would pose a real problem, and one or more characteristics might have to be ignored.

In many cases, the shape of the rough alone will determine the style and size of the finished gem. Various shaped pieces of rough are shown in Figure 75. The specimen A has been sawed into a nearly cubic block in preparation for a

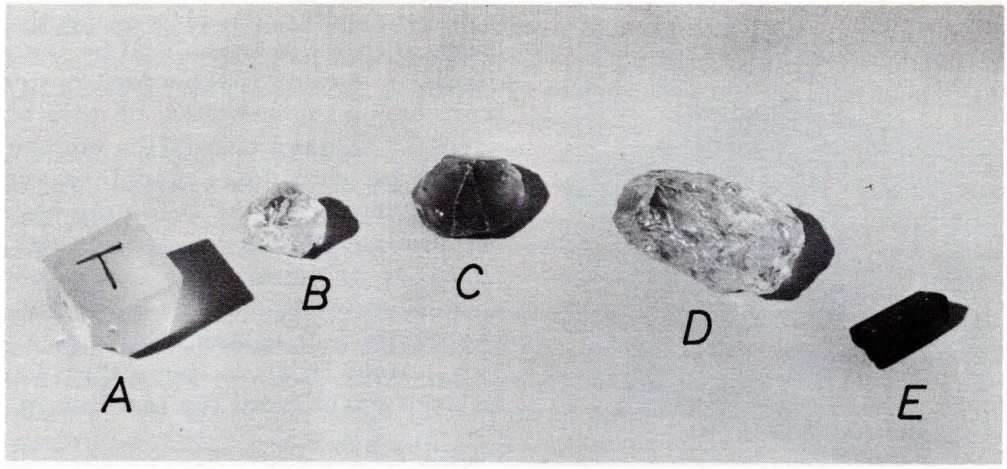


Figure 75.
Faceting Rough Ready for Preforming.

round brilliant, with T denoting the future table. It will next be ground into a cylinder. Specimens B and C are naturally shaped to be ideal for round brilliants, and will need only a slight amount of grinding to produce preforms. Specimen C, a portion of the tip of an amethyst quartz crystal, should be oriented with the crystal point as the culet. Specimen D is a very irregular piece, and in order to prepare for preforming, it must be trim-sawed. The piece would best make two or more gems. Specimen E, a tourmaline crystal, needs very little grinding as it is an almost perfect preform for a rectangular gem. This type of crystal may be dopped and faceted without any preforming.

In many gem minerals, if the color is evenly distributed, if there are no cleavage planes, and if there are no flaws, the choice is simple. In others the rarity and value will force one to allow the size and shape of the piece of rough to determine the size and type of cut. Orienting for any cleavage may be the only necessary consideration.

As an example, benitoite, a one location mineral, appears only in small pieces seldom over four carats. Under ideal circumstances the largest stone possible from a four carat piece of rough would be about one carat. A benitoite gem of this size is excellent. If the four carat piece of rough contained a small flaw and was color zoned, it might be necessary to reduce its size to about two carats in order to remove the flaw and correctly orient the color zoning. The resultant gem would only be about one-half carat. Certainly only the brave and most pure in heart would reduce such a gem in half. A small flaw and some color zoning in a one carat benitoite gem would not be a serious detraction.

The Use Of The Trim Saw

After the final decision as to the shape and approximate size of the gem, it will be necessary to give it a preliminary shape. A piece of machinery that will assist in the preliminary steps to the preform is the trim saw. A saw of this type is shown in Figures 76 and 79. If a flaw needs to be removed, a trim saw will do it nicely and perhaps save a small piece of the rough for another stone. A faceter's trim saw will pay for itself in rough that is saved. This type of saw is a smaller version of the regular type trim saw, and uses a very thin blade of about twelve-thousandths (.012) of an inch thickness. Trim saw blades of only

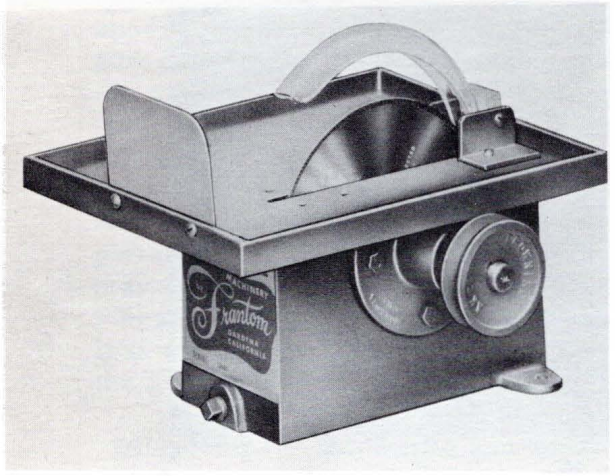


Figure 76.
The Frantom Faceter's Trim Saw.

Photograph courtesy of
Frantom Lapidary
Equipment Company.

ten-thousandths are also available. A blade of this thickness will be instrumental in saving much rough material from becoming sawdust. A thin blade needs to be used carefully, but the instructions with these machines are such that anyone can soon learn the correct technique. The saw should be run in kerosene or some other type of coolant. Even if water is used as a coolant (not recommended) splash is always a problem. Most faceters use a trim saw in an area apart from the faceting machine.

When removing a flaw by sawing, the blade is usually run through the flaw and parallel to it. It is preferable to place the saw cut, in relation to the largest mass of the rough, just outside of the flaw. It is not considered poor technique to allow the flaw to remain on the surface of the piece to be preformed. This may save a gross miscut from taking place. The flaw and any thin layer to the outside of it may be quickly ground away later. In the case of splitting a piece of rough into two sections, the saw should run exactly through the flaw if possible.

If the sawing is done along some kind of mark, the mark should not dissolve in the coolant. For kerosene, the water color type felt point pen is good. Most ordinary inks will not adhere to the surface of gem materials. If they do, they usually wash off as soon as the coolant strikes them. If water is used as a saw coolant, the waterproof felt point pen is excellent.

It is only necessary to saw off large sections from the piece of rough. Trying to remove all protuberances or to do shaping is usually not wise. The thin saw blade can easily be bent out of shape with side pressure, and its useful life can be greatly curtailed. Only straight cuts through the gem material should be attempted. Under these circumstances, a thin blade will trim many hundreds of average size pieces of rough. The use of a trim saw in producing a preform is shown in Figure 77. The piece of rough with the projected preform is shown at

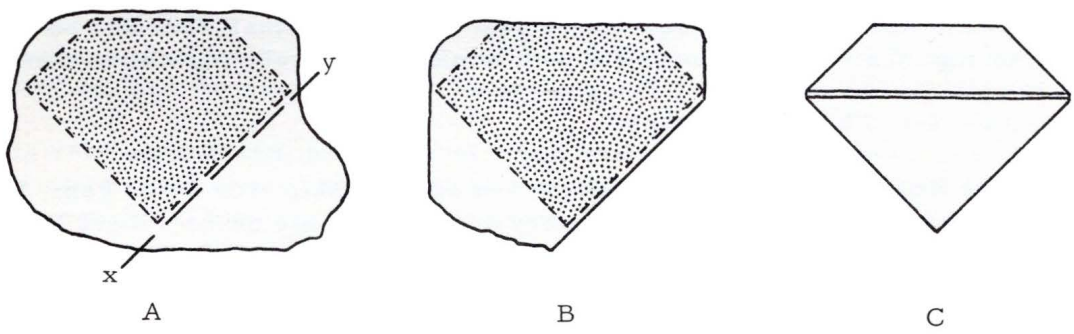


Figure 77. Preforming a Piece of Rough into a Round Brilliant.

A. It would be best to saw along the line x-y to save the large corner. Step B shows the piece of rough sawed and ground to a cylinder. The table area has been flattened. The completed preform is shown at C.

When sawing a highly cleavable material, always start the process with the pronounced cleavage at nearly right angles to the saw table. The blade should enter the piece of rough so that its edge is as parallel as possible to the cleavage plane as shown in Figure 78.

The sawing of a transparent piece of gem material leaves a frosty surface that scatters the light so that it is difficult to see into the piece of rough. If further searching for flaws is done in the immersion liquid, this frosty surface is of no consequence, but when the rough is viewed in air, it will be impossible to see any type of inclusion, and there sometimes is a marked color change. This may

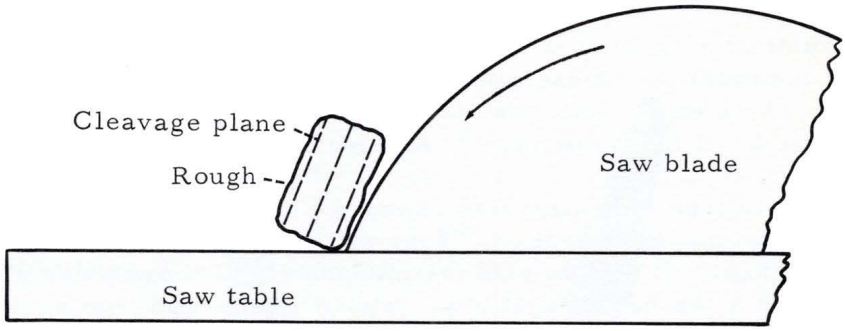


Figure 78. Sawing a Cleavable Mineral.

be overcome by coating all sawed surfaces with clear nail polish. The coating leaves a smooth transparent surface that will be nearly identical to a fracture surface.

Dopping For Preforming

After sawing is complete, it is necessary to attach the embryonic preform to a stick for ease in handling during grinding. The stick to which the stone is attached is called a dop stick, and the cement is known as dopping wax. The attaching of the stone is known as dopping. For preforming, the dop stick is usually a small wooden dowel. The dopping wax used here may be any low melting point wax used in the process of cutting cabochon gems.

When the piece of rough is cemented to the wooden dop stick, care must be taken to insure that the portion intended to be the crown is adjacent to the dop stick. An imaginary line from the proposed culet through the center of the rough and to the center of the dop stick will become the vertical axis of the gem. This axis must be in perfect alignment with this dop stick and all other dop sticks in later steps of the faceting process. Careless dopping at this stage can result in loss of valuable material.

Warming The Stone

Before the stone can be attached to the dop stick it must be warmed in order

that the dopping wax will adhere to it. The species descriptions in Appendix I give the heat sensitivity for all gems listed, and should be consulted for each gem material before attempting this step. Materials that are very heat sensitive are discussed in Chapter XII. Those that are not heat sensitive may be safely dopped by one of the following heating methods.

When a low melting point wax, about 150 degrees Fahrenheit, is used, it is possible to dop materials of very low heat sensitivity without applying heat other than to the wax. Small amounts of hot wax may be applied to the stone, allowed to remain in contact for a second or two, and then removed. A number of applications of this type will result in the stone being warmed until the small blobs of wax begin to adhere. At this stage the portion of the stone next to the dop stick may be completely covered with wax. This portion of the stone is to be the crown of the preform.

The Use Of Dopping Plates

The better method of heating is with a dopping plate. There are a number of such units on the market. These allow the rough to be placed upon them and slowly heated. An electric flat iron, turned to the lowest heat and set face uppermost, will do as a dopping plate. An electric frypan is also excellent.

Regardless of the type of heating unit used, the stone should be placed on the unit while it is cool and heat applied. This will insure that it is subjected to gradually rising heat. It will be safe for moderately heat sensitive materials as well as those with a low heat sensitivity. Those with a high heat sensitivity should be handled as outlined in Chapter XII.

Some commercial dopping plates are designed so that the gem material may be placed out beyond the area of greatest heat and then be gradually moved toward it. As there are few gem materials that can be considered to be completely safe and insensitive to heat, any unit that will allow the heat to rise slowly is best.

Grinding The Preform To Shape

When the stone is dopped, and the wax has cooled, the grinding process may be started. Grinding is done on a lapidary grinding machine, shown in Figure 79 below.

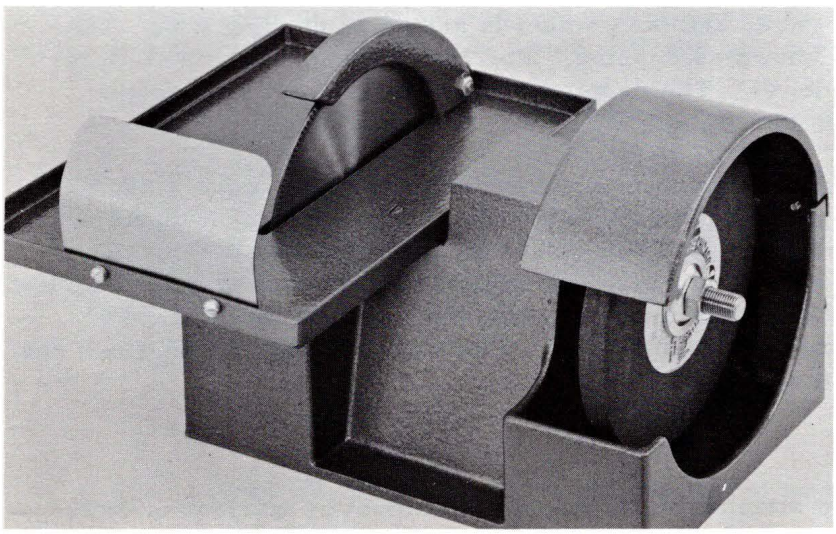


Figure 79.
The A.D.M. Rock Rascal.
Photograph courtesy of
A. D. McBurney

It is possible to preform round stones and perhaps a few other shapes on the coarse or extra coarse lap of the faceting machine. Using the faceting lap can be an acceptable practice if a grinding machine would need to be purchased only for this purpose.

Grind Carefully

Many gem materials are brittle and few of them exhibit the toughness encountered in agate. The faceter must exert as little pressure as possible in order to correctly grind the preform. The usual coolant for grinding wheels is water, and if the stone is forced against the grinding wheel with great pressure, the space between the stone and the wheel may be so small that the surface tension of water may not allow it to enter. If this is the case, the wheel is in a sense running dry. Even when the wheel is wet, a great amount of heat is generated with such small surfaces in contact. When we realize that most gem materials are brittle, it is imperative that the grinding wheel be perfectly round. Truing directions may be obtained with the purchase of any good wheel dresser to be found at a lapidary supply.

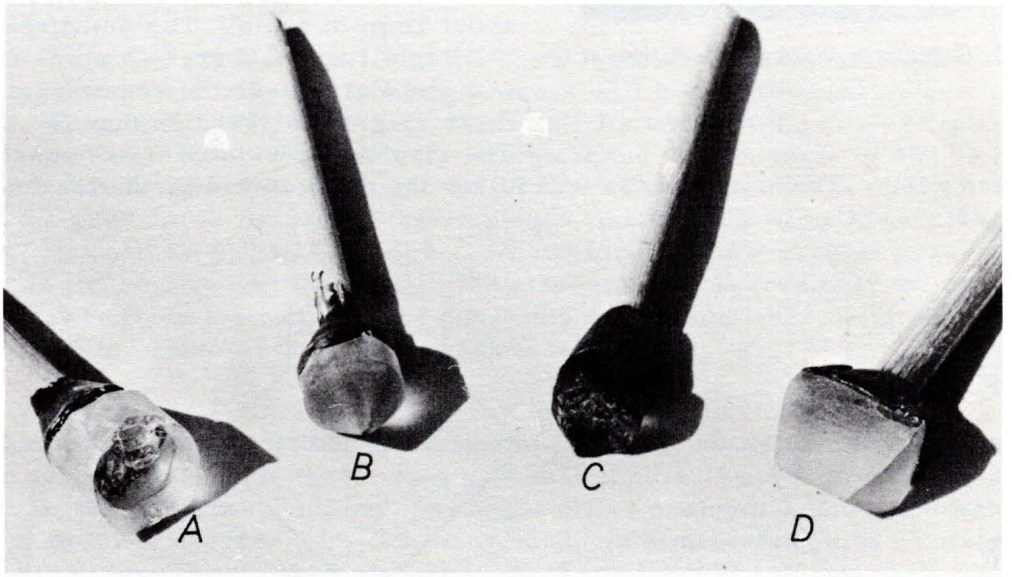


Figure 80. Steps in Making a Preform.

Figure 80 shows the steps in making a preform. A piece of rough ground to a cylinder is shown at A. The portion intended to be the crown is attached to the wooden dop stick. The pavilion is completely shaped at B. At this point it is ready to turn on the dop stick as shown at C. Here the crown is ready for preforming. The roughly flat portion will become the table facet. At D the pavilion of a step cut is ready to turn on the dop stick in preparation for preforming the crown. Finished preforms are shown in Figure 86.

Outline Is First Shaped

If the gem is to be rectangular, then the rough should be ground into a block. If the stone is to be round, the shape should become cylindrical, as a result of grinding as shown in Figure 81. All chips and cracks on the surface should be removed. A flat band, at least as wide as the projected girdle and on the same plane completely around the stone, must be achieved before moving to the next step. An oval preform would become an oval cylinder; a freeform preform

Figure 81. Grinding a Piece of Rough into a Cylinder.

would take on the desired girdle outline, etc. The outline, viewed from above, should be as perfect as possible. This is especially true for round stones; they should be perfect cylinders. Any deviation will result in wasted time or gem material in later stages. When the outline is perfect, the width of the gem has been determined, and further cutting will not greatly reduce it. This is important before the next step is attempted.

When the outline has been completed, the depth of the stone in relation to width must be determined. For simple brilliant stones, the depth must be about 75% of the width. As an example, a cylinder intended to be a standard brilliant that measures 10mm in width, must be about 7mm in depth. The multifacet brilliants require a greater stone depth, with the Portuguese cut requiring a depth as great or greater than the width. The step cuts normally are of equal depth and width. Ordinarily these will follow the depth to width relationship of Figure 82.

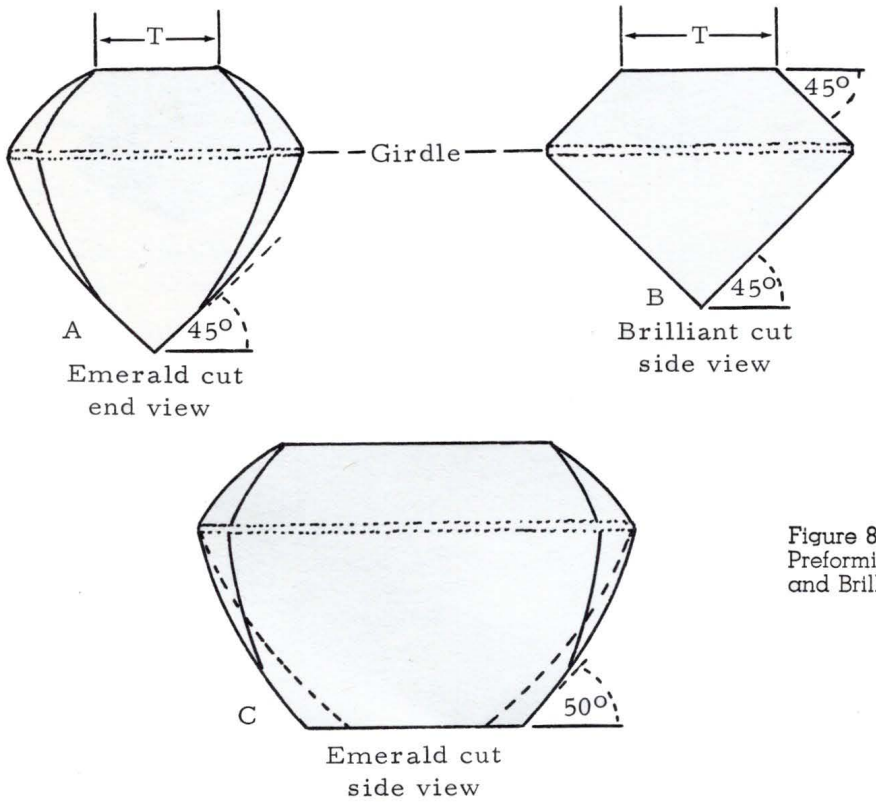


Figure 82.
Preforming Outlines for Step and Brilliant Cuts.

In each case the culet portion must be brought to a point of about 45°. In the step cut, outline A, the lines from culet to girdle, and girdle to table must be a curve as shown in order to accommodate the middle rows of facets. The dashed line, shown in the side view C, is the approximate line of the end facets when finished, but it is recommended that the preform follow the solid line. The standard brilliant outline is shown at B, and all simple brilliants should have this outline. Multifacet brilliants should assume the outline of A. The The table width (T) is 50% of stone width for the brilliant, and somewhat less for the step cut and multifacet brilliants.

Careful attention must be paid to the depth-width relationships. If there is not enough depth of material at this stage, the girdle outline will need to be decreased in size until it matches the amount of depth on hand. There must be enough depth to produce a correctly proportioned pavilion, otherwise angles may need to be changed in order to complete the pavilion. The crown may be lowered a small amount if necessary to conserve costly materials, but the pavilion is difficult to alter.

Preform Angles

If the projected standard brilliant gem is a member of the quartz group, the angle at the culet during the faceting process will be 43° (making an overall arc across the culet of 86°). It is important that the angle of the culet of the preform be not less than 43°, and it is recommended that an angle of 45° be created in order that there is some margin for error. This is shown in figure 82B. When the preform is for any of the step cuts or a multifacet brilliant, the angle at the culet will be 45° with a gradual sloping off toward a greater degree as shown in figure 82A. In the case of the step cuts this is true only for the longer sides viewed from the end. In any case, the angle at or near the girdle should conform to the angle of the future break facets.

For gem materials other than quartz, the angle at the culet may be changed in relation to the difference between its culet angle and the quartz culet angle. Under normal conditions there is no gem that should be cut with a culet angle less than 40°. Correspondingly, the angle of the preform cannot be lowered more than three degrees. On the other hand, gem materials with a refractive index lower than quartz should closely adhere to the 45° angle at the culet, or should be given a steeper angle to insure enough pavilion to create the deeper gem needed for its lower refractive index.

The preforming of the culet to 45° is satisfactory for most materials. Only when the material is costly, or other factors call for frugality should the angle be changed. Lowering of the culet angle of the preform is in order when the gem is of a deep color. The method of lessening color hue is outlined in Chapter VII.

Preforming The Round Brilliant Pavilion

The pavilion of the round brilliant is a simple cone. This is accomplished by holding the cylinder to the grinding wheel as shown in Figure 83. If the dopped cylinder is carefully rotated at the 45° angle, the cone will be correct. If the gem is to be a multifacet brilliant, the culet portion is rotated at 45° until the culet tip is outlined, and then the angle in relation to the grinding wheel face is decreased to create the curve.

Figure 83. Preforming the Pavilion for a Round Brilliant.

Figure 84. Preforming the Pavilion of a Step Cut.

Preforming The Step Pavilion

The step cuts are preformed as in Figure 84. Here the correct curve is created by changing the angle of the dop stick in relation to the face of the grinding wheel along a vertical plane.

When preforming any of the forms of the step cuts, it is wise to bring only the long facets to the correct curve from culet to girdle. The end and corner portions of an emerald cut, for example, should be allowed to remain steep and not reach the proposed culet position. This is shown in figure 82C. Overgrinding of these ends and corners is easy, and if done, the stone may later need to be reduced in size. This is also true for freeforms. A check of the cutting instructions for one of the step cuts will show that the smaller end and corner facets are cut following the larger side ones. Any excess material that needs to be removed from the ends is only a small project on the faceting lap.

Planning For The Crown

When the pavilion is being preformed, it must be remembered that a correct amount will need to be reserved for the crown. As a general rule, the crown is one-half as deep as the pavilion. If the preform of a standard brilliant is made so that the pavilion is a 90° cone, it is automatically one-half as deep as it is wide. The crown is a similar figure, with the exception that it is truncated where the table is one-half of the girdle width. The crown height, as a result, is only one-fourth the girdle width. The crown and pavilion added together now equal three-fourths of the girdle width. If the suggested preform angles are followed, the crown height of one-half the depth of the pavilion (or the one-third crown and two-thirds pavilion as suggested by many authors) is automatically achieved.

When the pavilion is correctly preformed, the stone is removed from the dop

stick and redopped with the crown portion up. The crown is ground to nearly the same angle as the pavilion, as seen in Figure 85. In most gem species the crown angles are less than the pavilion angles, and accordingly the crown may be preformed at a lesser angle. The angle will depend upon the gem species, and may be found in the species descriptions.

In the case of the step cuts or the multifacet brilliants, a curve is induced into the pavilion of the preform. There is a similar curve in the crown, but this is flattened in relation to the pavilion. This may be seen in Figure 82.

It is important that the crown be preformed; if not, the dopping wax would be holding against a flat surface, and the slightest jar may break it loose. If the crown angles are ground onto the preform, the dopping wax now grips the edge of the table and the crown.

Figure 85. Preforming the Crown of a Round Brilliant.

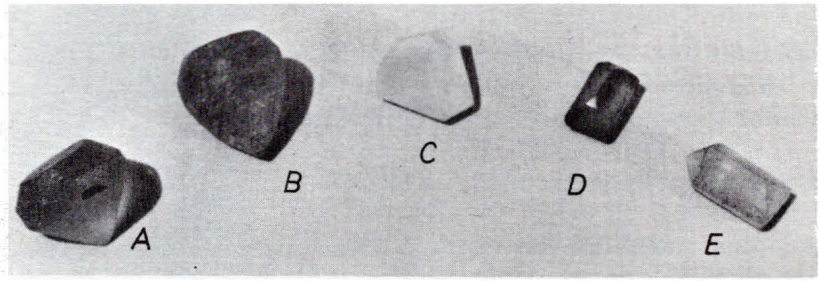


Figure 86. Types of Preforms.

When the crown is correctly preformed and the table is the desired size, the stone is ready for the faceting process. It should be removed from the preforming dop stick.

Recently devices to assist in preforming ovals, pendeloques, etc. have appeared on the market. One of them is shown in Figure 87. By making adjustments of the assembly along line 0 - 0, it is possible to create the correct curve.

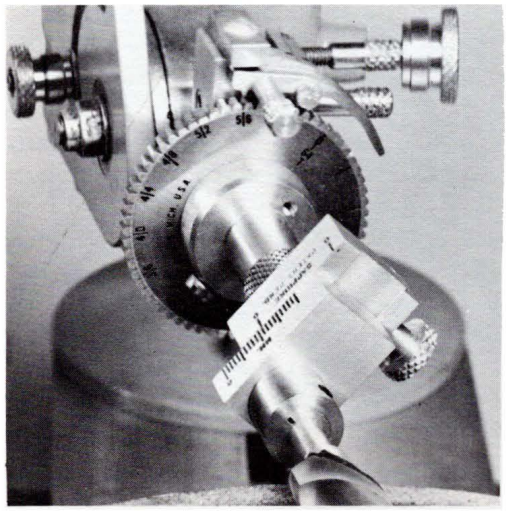


Figure 87. The Sapphire Offset Head Assembly. Photograph courtesy of Arrow Profile Co.

DOPPING THE PREFORM FOR THE FACETING PROCESS

The preform should be scraped clean of any wax used in the preforming process. Soaking in alcohol to soften any remaining dopping wax will lessen the possibility of chipping during the wax removal. The preform is now ready to be dopped onto a metal dop stick to be used in the faceting machine. The dop stick used for the first stage of faceting is a blunt metal rod, as shown in Figure 88, A, B, C. The stone is dopped with the table in contact with the end of the stick.

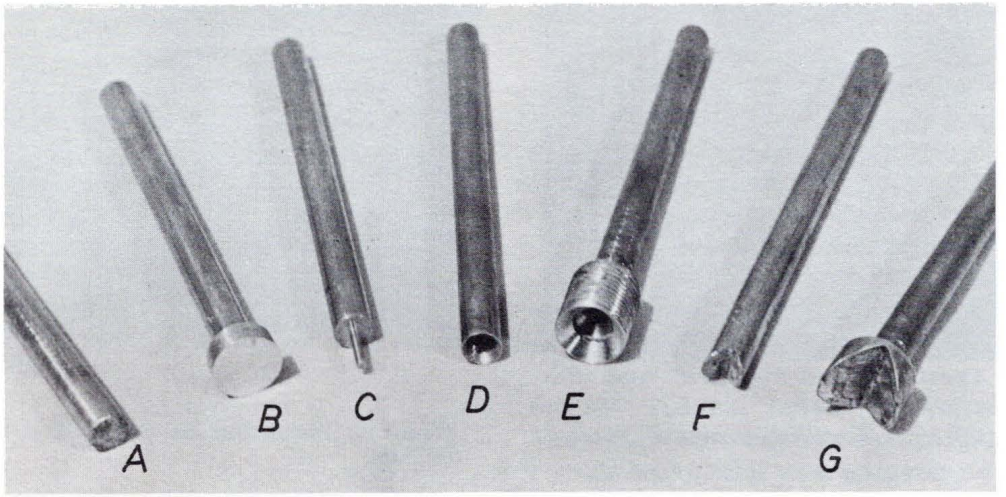


Figure 88. An Assortment of Dop Sticks.

The wax used for this process should have a melting point between 200 and 250 degrees Fahrenheit. This melting point is desirable as the wax will not soften with the heat generated during the polishing process.

Shellac As A Facet Wax Binder

Most dopping waxes do not readily adhere to a stone unless much heat is applied. The heating of most faceting materials is risky and should be done with great care. Coating the preform surface with shellac (see Appendix II), letting it dry, and then dopping has some advantages. The shellac when dry adheres strongly to the gem, making a perfect bond. The dopping wax, which is mostly shellac, will bond perfectly to the shellac coating. With this method the amount of heat necessary to make this bond is very low. It is necessary to raise the temperature of the gem slightly in order that the wax may adhere to the shellac, but it is not necessary to have it closely approach the melting point of the wax.

Dopping wax is best applied a small bit at a time to the heated dop stick. When there is a small ball of melted wax on the tip of the dop stick, the gem is applied, balanced in position, and small blobs of melted wax are applied to both dop stick and stone, bridging between them. This method is shown in Figures 89 and 90. It is important that the dopping wax not be so overheated that it burns. The melting of only a small blob on the end of the stick of wax as shown is all that is necessary. When a small blob of wax is melted, it is quickly applied to the stone or dop stick, and the process repeated.

A preform holding plate is shown in Figure 90. It should be made of aluminum, at least one-half inch thick. A number of 90° conical holes of various depths (and diameters) are reamed into the surface. These holes are shown

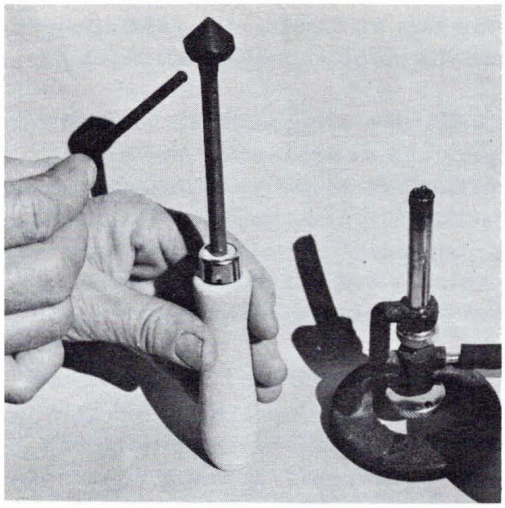


Figure 89. Dopping a Preform.

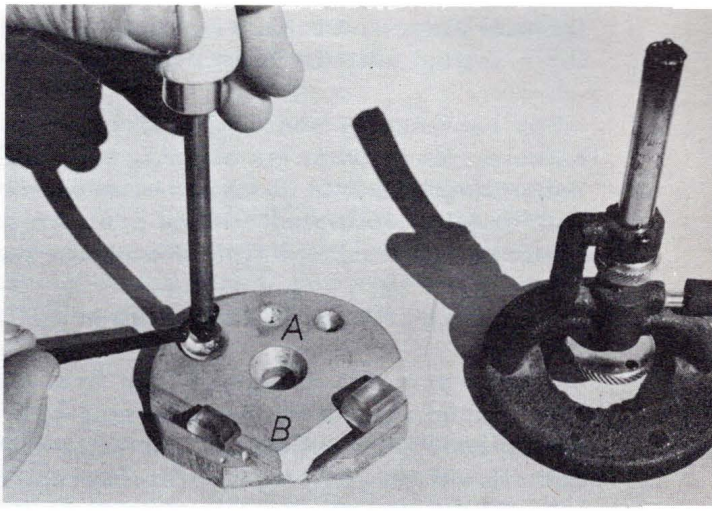


Figure 90. Dopping with a Preform Holding Plate.

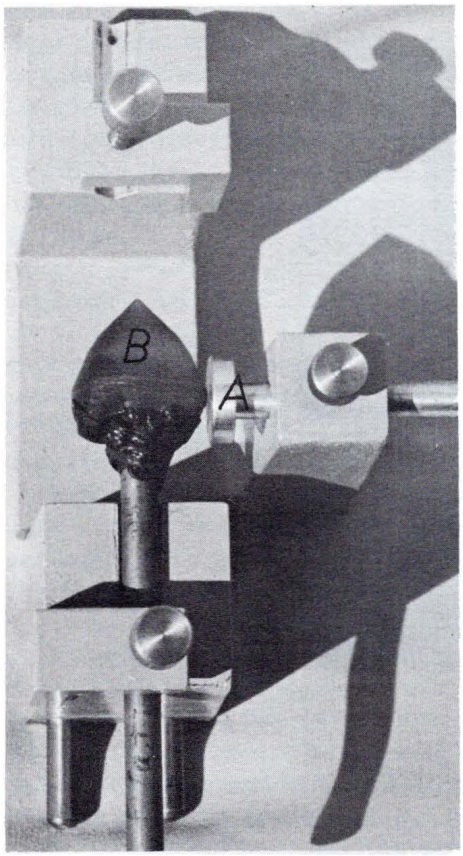


Figure 91. Aligning a Newly Dopped Preform.

at A. At B are shown V-shaped grooves of two widths to hold rectangular preforms. The grooves should have the usual step cut curve. The block may be placed, with the preform in the correct hole or groove, onto the warm dopping plate, and at the correct temperature, dopping may proceed. The block will hold heat after removal from the dopping plate. A dop stick holder comparable to that shown may be made by drilling a hole, to match the dop stick size, into an ordinary file handle obtainable at a hardware store. The hole should be about one-half to one inch deep.

Aligning The Preform

When the correct amount of wax has been applied, the preform must be aligned so that the axis of the stone is in a direct line with the axis of the dop stick. This is done while the wax is still warm. In the case of freeforms, alignment with the eye is satisfactory, as there is no perfectly central axis. In the case of round, oval, and rectangular stones, a dopping fixture with an aligning pin is necessary. For a round preform, the dop stick is rotated in the fixture with the stone against the aligning pin as shown in Figure 91. If the two axes are not in line, the stone (B) when rotated, will move away and toward the aligning pin (A). In this case,

the wax may need to be rewarmed by heating the dop stick slightly, and the preform shifted until it rotates at exactly the same distance from the aligning pin.

For rectangular and oval preforms, the two ends are aligned to be exactly the same distance from the aligning pin, and the process repeated for the sides. Some modifications of this method may be in order for some of the other shapes that may be attempted. If the preform is carefully aligned, there will be little waste of material and time during the faceting process.

Redopping After Completion Of The Pavilion

When a preform is dopped, the first step of a two step process is completed. The second step is the transferring of the gem to another dop stick, and this is called redopping. This is done after the first half of the stone is completed, and allows the completion of the second half. Even though redopping does not take place until after the cutting and polishing of the pavilion, it will be discussed here because much of the same equipment and many of the same methods are used in both steps.

After the pavilion is completely polished according to directions, the dop stick and stone are removed from the faceting machine. A coating of shellac is then applied to the pavilion. When the shellac is dry the dop stick is placed in the redopping fixture as shown in Figure 92.

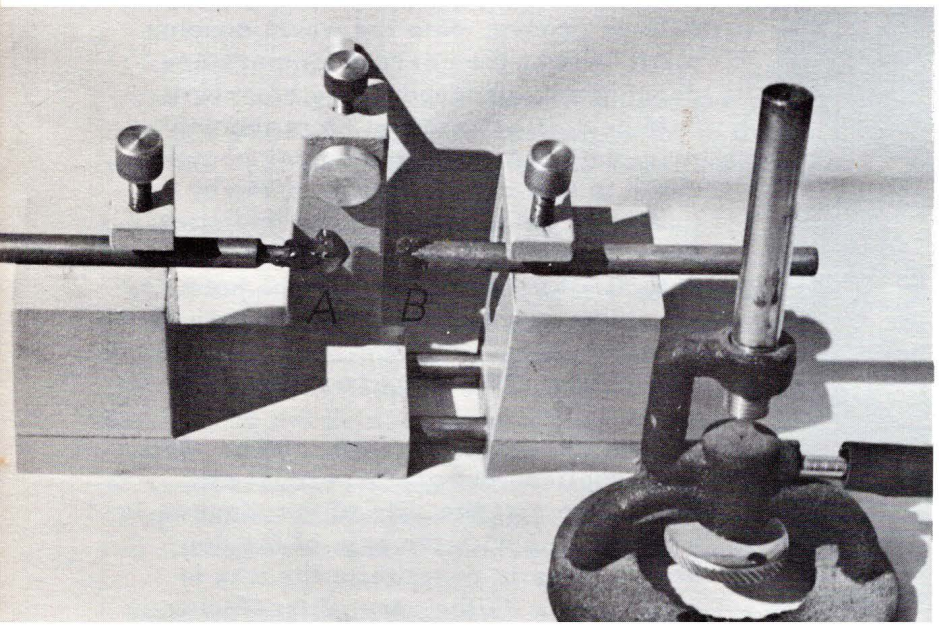


Figure 92.
Redopping a Half-finished Stone.

Types Of Dop Sticks For Redopping

The metal dop stick used in the dopping of the preform was a simple truncate rod, with the flat end accommodating the table of the preform. The dop stick used for the second step of the process is different and its shape should conform to the shape of the pavilion. The shape of various dop sticks is shown in Figure 88.

For the round brilliants, or other equilateral types, the dop stick ends in a conical hollow. When the stone is rectangular or with a culet ending in other

than a point, the dop stick ends in a V-shaped groove to fit the long culet edge. Any gems of an intermediate shape will use the type most suited.

Redopping Is Precarious

At best, redopping is a tricky process. Stones breaking loose from the dop stick after redopping is a common occurrence. The method of using shellac on the finished portion of the stone greatly reduces the possibility of this accident. The process calls for the placing of hot wax on the stone, and still not allowing heat to penetrate the stone and soften the wax on the opposite side.

Placement Of The Wax

When the dopped stone (A) is locked in the redopping fixture, and the decision made as to which type of dop stick is to be used, the stone is ready to be redopped. Heat from a small flame is applied to the dop stick (B) below the tip, and a small amount of wax is placed in the cone or slot. If the dop stick has been used previously, excess wax should be removed. All that is needed at first is the small ball of wax in the depression at the end. Excess wax may find its way onto the redopping fixture and possibly misalign the stone. The warmed dop stick with the melted wax in the tip is now placed into the fixture, with the dop stick in contact with the culet of the stone. The wax should be nearly liquid before this placement. The dop stick is locked in the fixture and more hot blobs of wax are placed around the stone and dop stick as in the original dopping. The amount of heat to be applied to the wax to make it correctly bond in this stage is gained only by experience. It is important to work as rapidly as possible in order that the second dop stick does not cool before all wax is in place. Wax should not project beyond the girdle, nor cover it. If this does happen, it may be removed later, when all wax is in place. After the second dop stick is secured, the excess wax may be easily removed by careful paring with a warmed knife blade.

Cooling And Separating Dop Sticks

After a sufficient amount of wax has been applied, the whole fixture should be allowed to cool. This takes a much longer period of time than might be expected. The dopping fixture, usually made of aluminum, absorbs a large amount of heat during the redopping process. This heat, as well as that of the wax and dop stick, must be allowed to dissipate. It is a simple matter to check the temperature of the dop stick with the fingers. The wax may be pressed with the fingernail. If it cannot be dented, it has cooled sufficiently to remove the dop sticks from the fixture and go on to the next stage of the process.

When the stone and dop sticks are cool, they are removed from the fixture in order to separate the crown from the first dop stick. First, a test of strength is in order. If the dop sticks are grasped, one in each hand, and a very small amount of pressure applied, as if trying to break them apart, one can readily detect a weak bond with the pavilion. Too much pressure will break a good bond, so caution must be exercised. If the pavilion bond breaks easily, the job was not correctly done and must be repeated.

Removing The First Dop Stick

The simplest and safest method to remove the first bond is shown in Figure 93. Heat is applied to the first dop stick (A) about 1/4 inch away from the wax. If

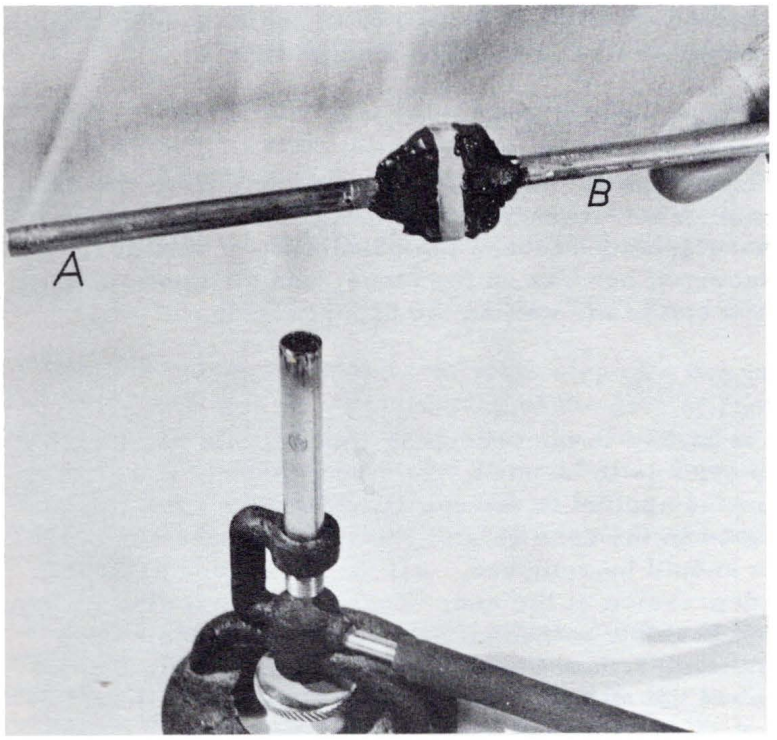


Figure 93.
Removal of the First Dop Stick after Redopping.

the second dop stick (B) is held as shown, the heated dop stick will fall free when the wax has melted. Do not pull the dop stick from the stone, let it fall free. Some wax will adhere to the stone, and it may be removed with the heated blade of a small knife. The removal should be fairly complete with all lumps and wax ridges removed.

At the same time, any overapplications in the adding of wax to the pavilion may be removed. Be careful with the knife around the girdle and pavilion facets, and especially at their junctions. These sharp ridges between polished faces are vulnerable to chipping. The knife should be warm enough to easily remove wax with very little pressure. The gem is now ready to return to the faceting machine for the cutting and polishing of the crown facets. The aligning of the crown to pavilion is covered in Chapter X.

Replacing Broken-off Stones

On occasion, regardless of how carefully one does all dopping, redopping, or cutting, a gem will accidentally be knocked off the dop stick. Nearly always, the break has irregular edges of dopping wax on both the stone and dop stick. It is usually possible to place the stone back onto the dop stick by orienting the broken edges of the dopping wax. If both surfaces are clean, and free of any chips of wax, it can be reasonably certain that the stone is again in correct alignment. All that is necessary now is to cement the stone back in position.

This is best done with a hot knife as in Figure 94. The dop stick is grasped with the end in the center of the palm of the hand, and the stone held in place with the index finger. The hot knife is placed across the break at about a 45° angle. The knife will melt a small amount of wax to either side, and should be allowed to sink down to the stone. It should be held in contact with the stone for a second or two. This will join the break at one point. Wait a few seconds

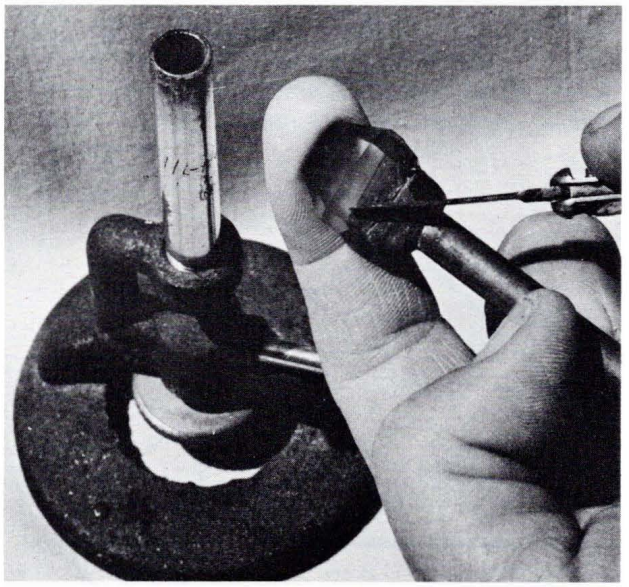


Figure 94.
Redopping a Detached Stone.

before sealing another part of the break. The stone should be turned, and a point on the opposite side done next. When two sides are repaired, it is not necessary to hold the stone in place with the finger for further repairing. Go completely around the stone, working on opposite sides, until the entire break has been sealed. It is very important that the job not be rushed. If the hot knife is placed too often in contact with the stone, the whole of the wax may become warm and soften. If this happens, the stone can be moved out of alignment.

When the repair is complete, the dopping wax will be rough and deeply incised. This may be smoothed by using the side of the hot knife blade. Any holes may be filled with a small blob of melted wax.

Chapter X

Cutting The Facets

THE PLACEMENT OF facets with a jamb-peg faceting machine is a difficult task. In some respects, the machine offers the operator an unlimited amount of freedom, but he pays for it in that he must be highly skilled in order to operate one successfully. The amateur faceter enjoys a similar but highly accurate machine, and this accuracy allows him to cut intricate patterns with perfection. Perfection sets the professional and amateur apart, regardless of what type machine each uses. The professional must turn his time into money, and perfection is secondary. The amateur is willing to put much time into the achieving of a perfect gem.

ACCURACY IS IMPORTANT

A glance at any of the diagrams in the literature will show that all facets meet one or more facets at very definite points. This makes a pleasing gem. In reality it is an assurance of a solid geometrical figure, and without it, one will never have a symmetrical or well balanced gem. In order to achieve this meeting of facets at the desired points, the faceter must exercise care that each facet is cut to the same depth as all others in the same row; and that all subsequent facets meet all previously cut facets at the correct points.

Two terms are used in respect to any errors in this process. They are overcutting and undercutting, and should need no clarification. Either situation may result in an unsymmetrical gem. Undercutting is no problem. When it is found, a bit more cutting should bring the facet to the point desired.

Overcutting must be handled differently. Whenever a facet is overcut, it must either be ignored (a deplorable practice), or the stone must be recut to make all other facets match the overcut one. It is possible on rare occasions to need to recut only the facets on a single row to conform with one that is overcut. A facet that is overcut "only very slightly" is really badly overcut as shown in Figure 95.

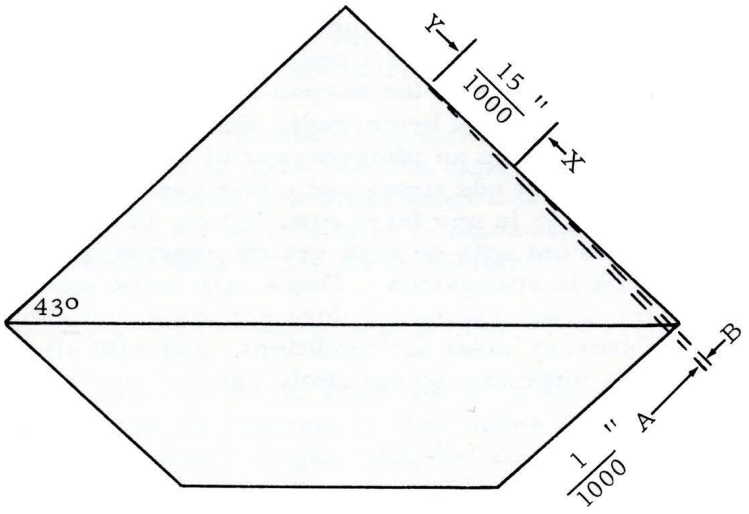


Figure 95.
Overcutting.

The outline of a faceted gem has a culet (main pavilion) angle of 43°. The dashed lines A and B are at 45° and depict the angle of the break facets. Line B intersects the main angle at X, one-half the distance from girdle to culet, the normal point of farthest reach of the break facet. The separation between line A and line B indicates an overcut of 1/1000 inch in depth. The tip of the overcut facet Y is about one-half of the distance from the correct point "X" to the culet. The distance X-Y then represents a linear overcut of 15 times the depth of the cut. For a one carat gem, a 1/1000 inch deep overcut represents a situation as above. Such a facet is badly overcut, and will push adjacent facets out of shape.

The Use Of The Angle Stop

The gauging of cutting is greatly facilitated by a good angle stop. The angle stop, when working correctly, will cause the cutting sound to change noticeably when the stop setting is reached. At this point the facet should be inspected. If the process is allowed to continue after the sound change, slight overcutting could take place.

The feature of the continuance of slight cutting after the stop is reached may be turned into a real advantage. If the angle stop is set at a position slightly higher than needed, the faceter has ample warning that the final point of cutting is approaching. If on inspection, the facet is not cut deeply enough, cutting may be resumed. This is done without changing the angle stop position. Do not apply pressure and spring the quill past the stop point. The trick is to let it cut slightly past the stop point. Waiting for the point of absolute cessation of cutting would be time consuming, but the act of going a short way into this decreasing cutting zone can help to insure against overcutting. Control of this final cutting after the sound change will give each facet the required finish.

Cumulative Error

One glaring fact remains; no matter how carefully one operates, a certain amount of undercutting and overcutting is always possible. This is especially evident after the second row of facets, and the result is cumulative error. Very small errors, unnoticeable at the time they are made, tend to accumulate and show later as large errors. No one, no matter how carefully he works, can cut all facets to exactly the same depth. It follows that they will not meet exactly at the correct points. They may appear to do so even under magnification, but they still are not exact. If a small error is made on a few facets in one row, and if by coincidence, a similar error is made in the second row near the same point, a facet or facets on the third row may not be correct. Such coincidental errors at or near the same point can easily be an idiosyncrasy of almost any machine. Cumulative errors will appear at odd times and under seemingly impossible conditions. An error may appear in one facet row, but not in subsequent rows. A number of gems may be cut with no such errors appearing, then they may appear for a number of gems in succession. There may be no explanation for most of these, but the lack of an explanation does not make them any less evident. Cumulative error is present under all conditions, and with all cutters. Such errors can be held to a minimum by carefully refining one's technique during the cutting process.

Facet Sizes Must Be Correct

The practice of making all facets the correct size, and meeting all others at the correct points, cannot be overemphasized. This achievement is the result of meticulous care in cutting. Leaving facets an incorrect size cannot easily be corrected during the polishing process, even though some advocate this. It is true that polishing removes a small amount of material, but it removes the same amount from each facet. If all facets are correct before polishing begins, they should conceivably be correct when polishing is finished.

The worst aspect of trying to polish out cutting defects is that, if one is not careful, he may have too few standard facets to use as models. The simplest and best method is to cut all facets to the size and proportions desired in the finished gem. When this is done, polishing will start and finish with a perfect stone.

Cutting Pressure

The most highly variable factor involved in the cutting process is pressure. Try as the faceter may, he will not exert the same hand pressure at all times. The inclination of the quill will have great bearing on this unevenness of pressure. This is due to the different elevation of the hand at various angle settings. The faceter must learn to compensate for these differences as he moves from one facet row to another.

Enough pressure must be exerted in order that cutting is done efficiently, but not so great that the facet is too rapidly cut away. Great pressure may result in two very undesirable features. First, it may tend to plug a lap with cuttings. The lubricant may not have time to clear them off. Second, the pressure may spring the quill past the angle stop, overcutting the facet.

Other Variables

Pressure is not the only variable of the facet cutting process. The nature of

the lap surface at the moment is of great importance. The number of diamond particles that can come into contact with the facet varies from time to time. Their size, and the amount they project above the lap surface, has an effect on the cutting rate. The facet size, and hardness of the material being cut, the amount of lubricant on the lap and its removal of cuttings, add their effect also. All of these make up a picture of many moods. Pressure has an effect on any or all of these; or perhaps, it might be better to say that these have a great bearing on pressure. If any of these variables are working adversely, the cutting rate declines, and the first act of the faceter, however unknowing, is to increase pressure. This increase may solve his problem, or only add to it.

At times, the variability of faceting laps may be used to advantage. The lap does not wear equally over the entire surface, with the central area getting the least use. There are times when a faster cutting rate is needed for a large facet. It is a simple matter to move close to the center of the lap and this area will usually do a faster job of cutting.

Cutting Cleavable Or Brittle Materials

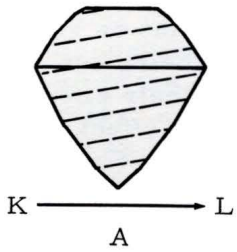
Some gem materials are brittle, or have an easy cleavage, or exhibit some other single characteristic that makes them difficult to handle. Most of these, when they appear singly, call for care in cutting facets. When two or more of these adverse characteristics appear together, the faceter must exercise special care. Gem materials below 6 in hardness that embody one or more of these problem areas are discussed in Chapter XII.

The first thing a faceter must determine, when cutting difficult materials, is that his cutting wheels are smooth and true. A hand charged diamond lap should be recently charged and sharp. A well used lap will tend to drag in the portions where the boart has been driven in, and the remaining particles that stand above the rest will tend to scratch and may take off chips or open cleavages. When working with difficult materials, the commercial permanently charged laps are best. They present a very smooth surface, with no protruding particles of diamond, and bumpiness seldom becomes a problem. They may cut more slowly than the hand charged lap, but in this situation, this slow cutting is an asset.

Cutting With The Cleavage

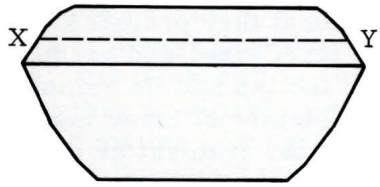
Those minerals that have an easily opened cleavage must be lapped according to the direction the cleavage lies within the stone. Figure 96 depicts a material with a single direction of cleavage. If the material has two or more directions of easily opened cleavage, directional cutting becomes more complicated. It could become necessary to completely map a stone showing the cutting and polishing direction for each facet. This is necessary for cutting diamonds*, and could be necessary for fluorite, which has the same cleavage. Sphalerite has six directions of cleavage, and mapping could be necessary here also. The amateur is more fortunate than the diamond cutter. Most of the gem materials available to the amateur have few cleavage planes, and usually only one is troublesome. Also, with very few exceptions, the gem minerals with very easy cleavages are soft, and no great pressure is needed to cut or polish them. The same is generally true for the brittle gems. The diamond cutter must exert great pressures and create high heat.

* See - Gems and Gem Materials, Kraus and Slawson; pages 120-121



A

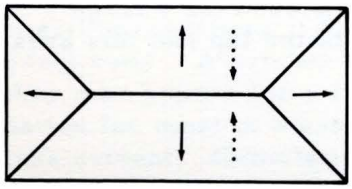
End view



B

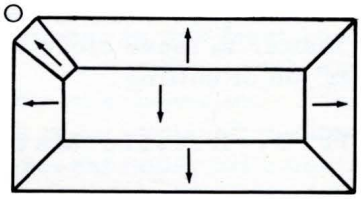
Side View

Figure 96.
Directional Cutting and Polishing.



C

Pavilion



D

Crown

An end view of a step cut gem, shown at A, indicates a 10° tilt of the cleavage plane shown by dashed lines. The line K---L indicates the direction of upward slope of the cleavage plane. The side view B shows the same cleavage plane as X---Y, parallel to the table. The view of the pavilion C shows the direction of cutting and polishing with solid arrows. The arrow K---L between C and D indicates the same cleavage slope as in A. If cutting or polishing followed the dotted arrows, cleavages would be taken off the culet. The crown view D shows the same general cutting and polishing directions, with the table needing one direction of lap movement. At O is a corner facet such as in the emerald cut. If either side of the cleavage plane X---Y in B is tilted downward from parallel to the table, the dashed arrows in view D indicate the respective change of cutting and polishing direction.

It must be noted that this directional cutting, as it is called, must be done for all facets on all sides of the stone. The illustration shows a rectangular stone, but the same is generally true for a round brilliant.

USING VARIOUS GRADES OF DIAMOND

When the cutting of a gem begins, the first rows of facets on either pavilion or crown should ordinarily be cut on the medium lap. See Table 6 (page 31) for the various lap grades. If the stone is large, in the vicinity of thirty carats and upward, it could be advantageous to start with a coarse lap. If the stone is to be less than a carat when finished, then a fine or extra fine lap would be the wise starting point. For most medium size stones the medium lap should be needed only for the larger main facets. The faceter should then change to the fine lap, recut all previously cut facets, and then cut all new facets on the same lap.

The multifacet brilliants, especially the Portuguese cut, are covered with

small facets, and may be cut entirely on the fine lap if the gem is to be no more than ten carats in weight. Stones to finish more than ten carats will need the medium and fine laps. Stone size and type of cut can have a great bearing on the grades of laps used. The table facet in most cases will need the same laps used for the larger facets elsewhere on the stone.

The step cuts follow a slightly different pattern of grades of laps. Except for a stone to finish less than two carats, practically the whole stone is cut first on the medium, then finished on the fine lap. The small corner facets of the emerald, and other related step cuts, are usually placed by using the fine lap, after the larger facets are recut with the fine lap. This will insure against overcutting of these small facets. Large step stones work nicely by being roughed out first with the coarse lap and then recutting the stone on the medium lap to bring the facets to the correct size.

The faceter will find that for most cuts, and all but the smallest of stones, the use of the medium lap followed by the fine will save time. This order will also allow for adjustment and correction during the fine cutting stage.

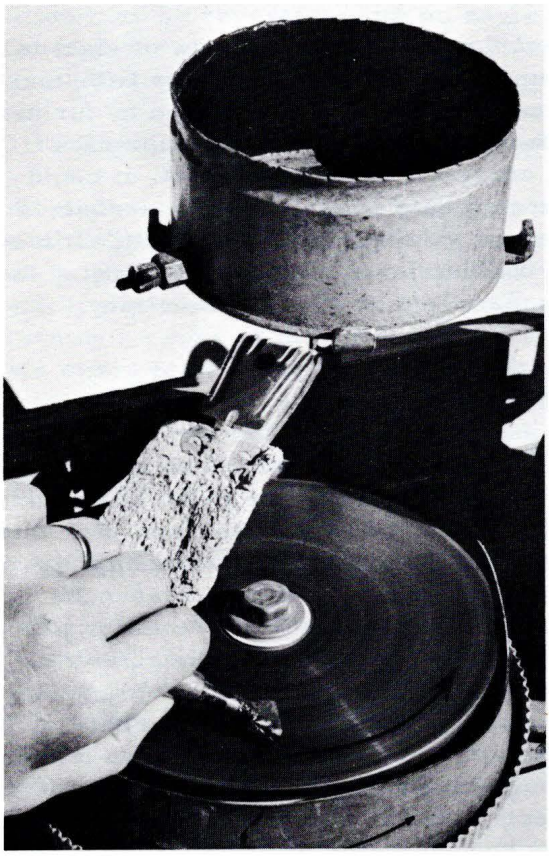


Figure 97. Direction of Turn of a Lap Wheel.

When using the diamond lap, the usual movement of the lap wheel past the stone is shown in Figure 97. This may be changed in special circumstances as discussed later. At the same time, the best technique is to swing the stone to and fro across the lap. This will wear the lap evenly throughout. Care must be taken to not slip off the edge of the lap, or strike the center nut. This movement should not be rapid, but a slow deliberate swinging.

THE CUTTING SEQUENCE

It is recommended that cutting and polishing operations be done according to predetermined sequences. If every operation is repeatedly done in a certain manner, speed and accuracy will be improved. Most faceters work out cutting sequences to fit their machine and their individual needs. At least at first, it is recommended that the cutting sequence offered with the diagrams be followed. At the same time, it behooves the faceter to set up certain points or positions on the index as starting points to do certain phases of cutting. Every row of facets should start with the largest numbered position on the index gear. In other cases where a row of facets is not involved, a certain index position should always be used. The best choice is the largest number of each index. This corresponds to the index division line (ID) on the charts in Figures 66, 67, and 68 (pages 98, 99, 100). Returning to this point for the beginning of every operation, routine or special, will

always orient the faceter. If a row of facets, such as stars for example, calls for a low number setting in order to cut the first facet; it is a simple matter to move from the ID setting to it, cut the row; and when the largest number of the index is again encountered, it is automatically known that the facet row is complete. A change of angle, if necessary, and then moving to the next required position, starts the cutting of the subsequent row.

The cutting of the table of all stones should always be done on the same setting of the index gear. This may seem to be making much of little, but in some situations, the table is cut and then not polished until after other facets are cut. When this is true, the relocating of the correct position to polish the table is much simplified. Orderly, repetitive operations pay in reduction of errors.

Cutting Out Of Sequence

It may be found that in order to correct a discrepancy in meeting of facets, it would be best to go back and recut. This technique is commonly used to correct other errors, and is recommended. This is cutting out of sequence, and it should be done as much as possible according to a predetermined pattern. After this pattern is decided upon, it should never be varied.

Let us consider the situation of finding that the third facet of a row of eight is not cut deeply enough. This may not be found until after the fourth or fifth facet is in place. The error is a common one, and can easily be corrected by further cutting. It would appear to be easy to go back and recut it. The assumption would be correct, but after going back and correctly cutting the facet, it could be forgotten that subsequent facets were already in place. If this were done, the index might be set at a previously cut facet and then it might be overcut. It is a better practice to temporarily forget facet number three and continue cutting the balance of the row. After all facets are in place, go back and correct any that need further attention.

Cutting The Pavilion First

It has been shown in Chapter VII that the inclination of the angles of the pavilion is of great importance in all gem species. Since this is the case, it would seem logical that the faceter's first attention should be to the pavilion. For this as well as other reasons, it is recommended that facet cutting start with the pavilion on all types of facet cuts and all types of gems. It is true that many faceters do this in reverse, but in many situations they are forced to alter pavilion angles in order to close the gem at the culet. The only reasonable way such cutters have to guarantee this closure with the correct angles is to preform the pavilion larger than needed. This is a waste of material. Such an act on the part of the faceter is made necessary by two situations. When the crown is done first, the faceter may not have allowed enough material for either crown or pavilion, and if he should cut the crown correctly, he is consequently forced to cut the pavilion incorrectly. If he did allow enough material in the preform, but made an error while doing the crown (or pavilion) and had to recut it, he will subsequently not have sufficient material left to finish the pavilion in a correct manner.

When we look at the above situations in the light of cutting the pavilion first, a different story unfolds. Regardless of preform shape, errors, or whatever is done, the pavilion can be cut to the required angles. If, when the crown is started, it is discovered that there is not enough material, the crown angles

may be altered, or the table enlarged. This altering has only a small effect on the finished gem. If an error of some consequence is made while cutting the pavilion, the stone may need to be made smaller, but it will be correct. There can be little argument against a small perfect gem, versus a large incorrectly cut one, especially if the latter happens to be a fisheye.

The Pavilion Cutting Sequence

The recommendation of pavilion first does not pose any problem to the faceter. It is just as easy to cut the pavilion first as last. Cutting the pavilion first may be done with any cut and any facet diagram. Some diagrams advocate cutting the crown first, and if this is the case, it is a simple matter to reverse the procedure.

Coupled with cutting the pavilion first is the act of placing the culet facets as the first step of cutting the stone. This is the greatest advantage of cutting the pavilion first. The culet facets are of greatest importance, and after they are in place attention may be focused on the remaining pavilion facets. Any diagram that may suggest the crown be cut first, will usually suggest that the pavilion begin with the culet facets. If this is not true, the cutting sequence for the pavilion may be reversed (with no angle changes) to start with the culet facets. The authors strongly recommend starting a stone at the culet and moving to the girdle and onto the crown.

CUTTING THE ROUND BRILLIANTS

Most facet rows on round brilliants can be cut consecutively beginning at an established point on the indexing device. The culet facets may be cut this way, but it is more accurate to do them alternately. As an example, a stone with eight culet facets should be cut by skipping every other facet, making four facets forming a cross at the culet. This is shown in Figure 102A, page 213. When this cross is perfect, with all four facets cut at the same angle, the culet is now at the exact center of the stone. When this is accomplished, the remaining four culet facets are cut to where their points reach the culet. All facets of subsequent rows on the round brilliants are usually cut in progressive sequence around the index.

Small Facets Call For Care

Most of the facets on the brilliants are small, and when the stones become elaborate, they are even smaller in proportion. A small facet takes a short time to be cut, and care must be exercised even on a fine lap to avoid overcutting. This potential overcutting is compounded when all facets on a stone are not the same size. Cutting time for various size facets must be changed accordingly. The faceter must carefully gauge the amount of time needed to correctly cut a facet of given size, and then try to duplicate this time for subsequent facets of the same size.

Cutting The Girdle

Any type of cut that has long facets adjoining the girdle must have other facets at 90 degrees placed on the girdle itself. This is true for all step cuts and modifications. It is also true for any five, six, or eight sided stone. If this is imperative for a large number of the facet cuts, why not place facets on the girdle of all stones? There are a number of arguments in favor of the practice, and

this has been done on occasion by professional cutters.*

First, the placement of facets on the girdle can insure the correct outline. It has a double check effect on the size of facets at the girdle. If any break facet is too large or too small, the girdle facet will not match it, and the discrepancy may be immediately corrected. Second, girdle facets give a stone a completed appearance. The junction, created by the joining of crown and pavilion facets with the girdle, is even and imparts a cleanness of line. Third, the girdle when faceted is the same depth completely around the gem, contributing to a greater ease in setting it into jewelry. Figure 98 shows a comparison of the two girdle types.

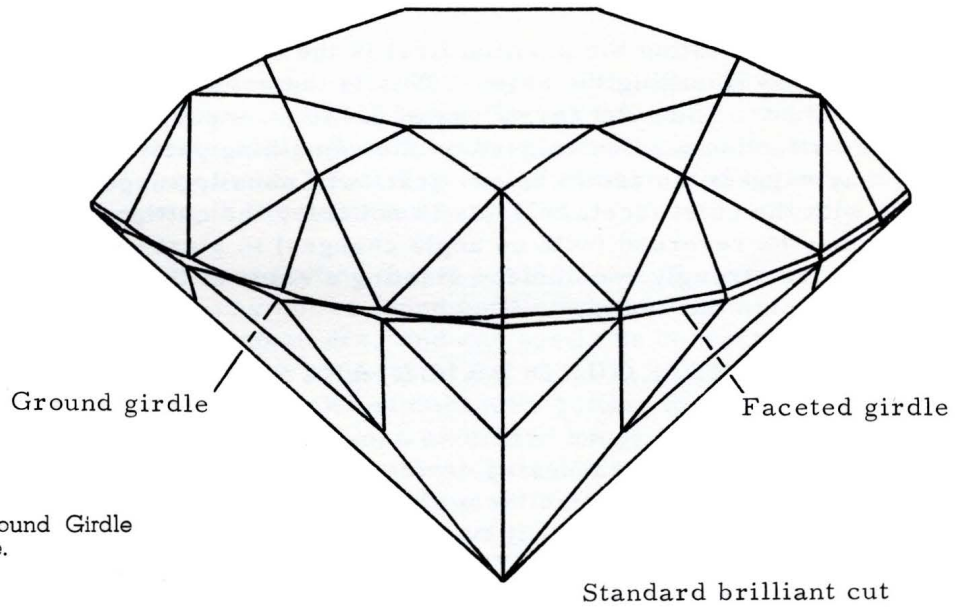


Figure 98.
Comparison of Ground Girdle and Faceted Girdle.

When the girdle is ground to a circle a certain amount of material must be allowed so that the thinnest portion, at the midpoint of adjoining crown and pavilion facets, does not become a knife-edge. Figure 98 shows this potentiality. Some authors recommend allowing 2% of the total stone depth for the girdle. This figure is difficult to arrive at, and fluctuates in relation to stone depth. If instead, the faceter places facets on the girdle when the pavilion is cut, he may leave almost any reasonable girdle depth when he cuts the crown.

When the cutting of the pavilion and the girdle are completed, the pavilion and girdle facets are polished according to the directions given with each type of cut. The leaving of at least part of the girdle unpolished assists in aligning the crown to perfectly match the pavilion.

Aligning Round Brilliants

If a gem is to exhibit maximum brilliance, the facets on the crown must lie directly over their counterparts on the pavilion. The faceter must give special attention to alignment before starting the second half of the gem. He will find

* See - Gems, Webster; page 373. Also - Revised Lapidary Handbook, Howard; page 136.

the method of faceting the girdle as outlined assists in this aligning process. To align round brilliants, the faceter finds himself faced with two problems. First, the facets of the girdle are small and placing them flat to the polish lap is somewhat difficult. Second, on stones such as the round brilliant, only the break facets reach the girdle, and they are of equal size. The mains reach the girdle between them, but it is practically impossible to determine between which two break facets the main lies. Dopping wax may be pared away for a short portion of the girdle and the main facet observed. This is a dangerous practice and a chipped girdle could easily be the result.

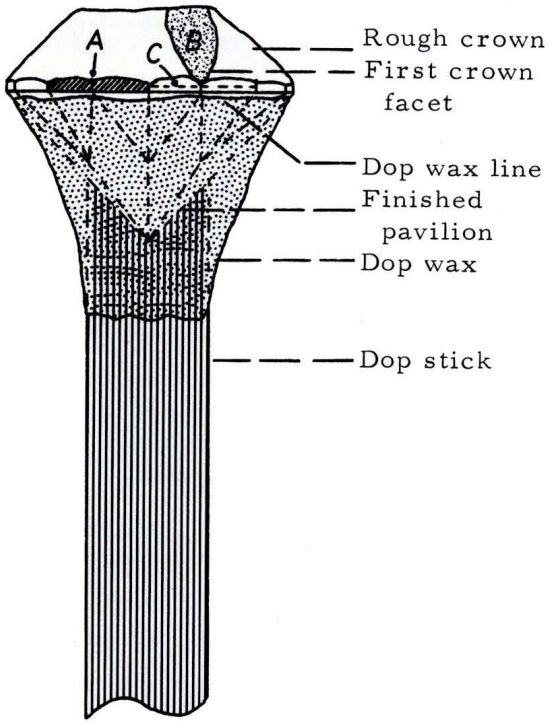


Figure 99. Orienting a Standard Brilliant after Redopping.

Figure 99 shows a standard brilliant that has been redopped. All girdle facets have been cut, and two of them are polished. The entire pavilion has been covered with dopping wax. To either side of A are the two polished girdle facets. The crown main facet lies between them. Cutting of crown mains may start at A or any other correct point such as B. The first crown main is in place at B. This facet has been cut to the future girdle height as shown by the dotted line at C. All other main facets should be cut to this same level.

If the directions for the standard brilliant are followed carefully, only two facets on the girdle are polished before the stone is turned. These two facets will lie one to either side of the main facet. Which main, is of no consequence. The point between these two facets can be temporarily aligned by eye to the main position. The indexing can be moved to either polished girdle facet, and that facet placed on the polishing lap. The stone, with the dop stick loose in the quill, is rocked very slightly on the lap until the position is found where it is flat to the lap, as in Figure 100. The dop stick is now locked; the index is

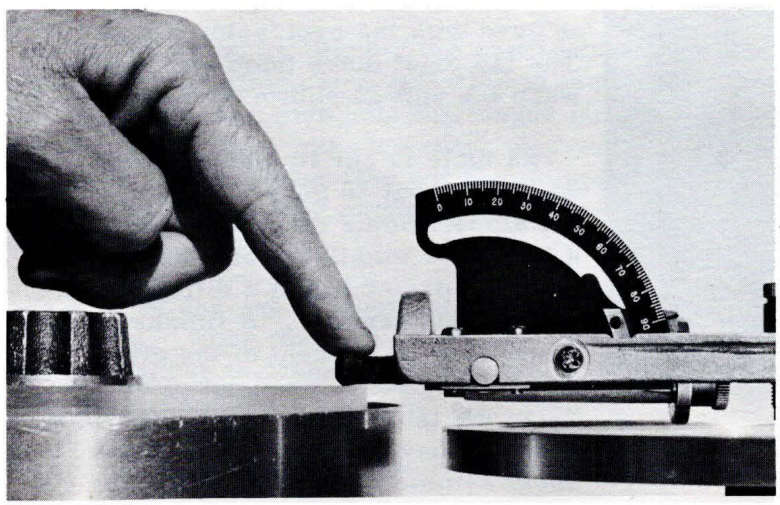


Figure 100.
Aligning a Girdle Facet to the Polishing Lap.

turned to an unpolished facet, and polishing started. If the stone is correctly aligned, the entire width of the facet will polish. If not, it must be realigned. The faceter is dealing with small facets, and two or more tries at realigning are not unusual.

Amount Of Girdle Needing Polish

In most cases, at the time of polishing the individual girdle facets are taller than necessary. Only a very small portion of each girdle facet nearest the pavilion will be retained, thus only that portion adjacent to the pavilion need be polished. This may be facilitated by changing the protractor setting to slightly above 90°.

Cutting The Crown Of The Round Brilliant

When all girdle facets are polished, the stone is ready for the placement of the crown facets. The first facets to be cut are usually the main facets. These are usually the largest of the crown facets and thus have a great bearing on the size and placement of the remaining facets. If the angle of the crown mains is steep, the others will be correspondingly steep. In the eventuality that the faceter finds that he does not have adequate material for a normal crown, he will need to lower the angle of the mains. If this change is great, the star facets may become nearly the same angle as the table. This may make the table appear ragged in outline. It is probably better under these circumstances to change the degree interval between the mains and stars to less than recommended.

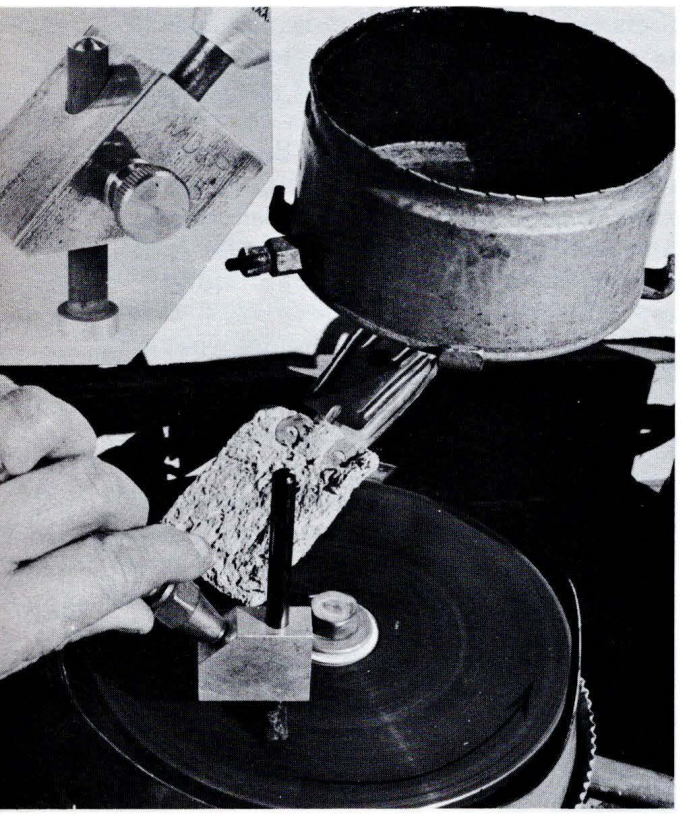


Figure 101.
Using the Forty-five Degree Dop.

The crown mains must touch the girdle at the final girdle height. See Figure 99. If the coarse lap is used for cutting the crown mains, the girdle should be left a bit taller at this stage, and later cut to the desired size with the fine lap.

Cutting The Table Facet

When the main facets are in place, the table is usually cut. The angle of the table is zero, but many machines need an attachment known as the 45° dop. This is pictured in Figure 101. This dop is used with the protractor set at 45°. The lap must move from the mast toward the unit as shown by the arrow.

The table is cut so that its finished width is about 50 percent of the width of the stone. Some facet diagrams call for a larger or smaller table, and some faceters prefer to cut a different size for various reasons. A finished table of from 40 to 60 percent of the girdle width is not to be considered out of balance. When the table reaches the desired size, it should have an outline the same as the basic symmetry of the stone being cut.

This may be an octagon when eight-fold, etc. If it is not equilateral, some of the main facets are not cut deeply enough, and should be corrected later. The table is usually polished at this time as outlined in Chapter XI.

When the table is polished, the stone is returned to normal position in the quill, and realigned to the previously cut main facets. If the outline of the table is not correct, it must be recut by slightly recutting the smaller main facets. All mains are now recut with the fine lap. Normally, all facets other than the main facets are cut with the fine lap, or the extra fine lap. The coarse lap would be used only with exceptionally large stones.

Placing The Star Facets

The slower rate of cutting of the fine lap is an asset in the placement of the small star facets. Each star facet must touch the one to either side, and not overlap at the junctions. This is best carried out by simultaneously cutting two facets. They are cut alternately, each a small amount, until they touch and are the same size. When this is accomplished, the remainder of the star facets may be cut in order, bringing each to touch the one previously cut.

Closing With The Break Facets

The angle of the break facets depends upon the size of the table. The table size is affected by the height of the crown. Thus, the break facet angles are dependent upon both factors working together. A small table creates a high crown, and results in a steep break facet angle. The inverse is also true. If the cutting was carried out according to plan, the correct angle should be close to the midpoint, between the limits suggested in the cutting directions. Assuming this to be true, a trial cut (on the fine lap) should be made. The finished break facet should meet other facets at the required points. The trial cut should quickly indicate if it is to reach these points at the same time. If it moves too rapidly toward the upper facet, the angle should be increased. If it moves too rapidly sidewise at the base, the angle should be decreased. When an angle change is necessary, turn to another break facet position for the second try. Any further trial cuts should always use a new break position. When the correct angle is found, the cutting sequence may be restarted with the first trial facet, or the trial facets may be brought to the correct position when they are again reached in sequence. The crown is now ready to polish as discussed in Chapter XI.

CUTTING THE STEP CUTS

As in the round brilliants, the cutting of step or mixed stones begins at the culet. The freeform is a variation of the step cut, thus it also follows this rule. In the rectangular step cuts the longer culet facets are cut first. On square or other equi-dimensional step cuts, all culet facets are cut in rotation as in the brilliant. If an oblong step cut has no appreciably longer facets, such as the cushion (Diagram 28), cutting then begins on the facets parallel to the longest dimension.

Cutting of any set of facets on the step pavilion progresses from the culet to the girdle. When the long facets are in place, cutting moves toward the ends. The last act is to place any small facets on the corners. See the cutting procedure, Diagram 27.

As a general rule, the facets of the step cuts are long and narrow. This

outline poses some minor problems. The most vexing is that the sides of the individual facets do not always stay parallel. This is partly due to the differential in lap surface passing under a long facet. The end of the facet that is nearest the center of the lap has less diamond passing under it than does the end nearest the edge of the lap. As facet length increases, in the case of a large stone, this amounts to a sizeable difference in amount of material being cut away. This is easily compensated for by the use of the cheater. Adjust the cheater so that the narrow end of the facet is cut more rapidly. After a few moments of test cutting, alignment may be checked by sighting down the facet. Any inequality of width can easily be seen. If a discrepancy is found, further adjustment of the cheater may be necessary. It is best to bring the facet into line with successive small adjustments of the cheater. Trying to do it with one single adjustment may easily end in overcompensating which is the same as overcutting. The use of the cheater should always be done with caution and moderation. The cheater is a marvelous addition to the faceting machine, but the quickest way to get into trouble is by using it excessively. Seldom is it necessary to use the cheater when cutting. Its greatest use is while polishing which is covered in Chapter XI.

The long facets may create a problem of correct alignment at the girdle. The stone circumference is great, and any slight inaccuracy will tend to force the facets to lie in the plane of a spiral. On occasion when the last facet of a row is cut, it will be found to be higher or lower than the facet it must match. The best cure is to go back and recut at least half of the facets concerned, using a small amount of cheat in the direction needed. As the error is cumulative, only a very small amount of adjustment will correct it. Making these long facets meet at the corners is easier than might be expected. Each facet is easily seen as the angle of meeting at the corners is ordinarily greater than ten degrees.

Aligning Step Cut Stones

The alignment of step cut stones after redopping is facilitated by the presence of the long girdle facets. It is simple to set the index at the required setting for any long facet on the girdle; then place the girdle facet in question onto the polishing lap. When the facet is lying flat on the lap, the dop stick may be locked in the quill. The stone should now be in alignment. This process is shown in Figure 100, page 209. Alignment may be checked by a slight touch of the facet to the polishing lap. If the facet does not polish for its complete width, unlock the dop stick and realign. When it is in alignment, all girdle facets should be polished.

Cutting The Crown Of The Step Cut

It is a simple matter to place the crown facets on most of the step cuts. Each girdle facet matches a facet on the pavilion below, and there should be a facet at the same position on the crown. The angle settings for the crown facets are different from those of the pavilion. The pavilion facets ordinarily have a ten degree differential, while those of the crown have one of about fifteen degrees. This differential is for a crown of three facet rows; one of more than three rows would call for a small angular differential. The sizes and proportions of these facets are shown on the facet cut diagrams.

Freeform crowns are cut in the same manner as above, using the same angles. There is the possible difference in that some freeform facet rows may not have all facets, due to the acute angle at some points on the girdle. In

Figure 64, page 95, the crown of those marked "X" have only one or two facets on one corner. This is a normal situation. The use of the freeform outline is helpful in saving rough material. The following of the general outline of the piece of rough is simple to do, and many pleasing effects can be obtained.

CUTTING DIRECTIONS FOR AN EIGHT- SIDED BRILLIANT

Even though the faceted stone diagrams herein and elsewhere in the literature are self-explanatory, the beginning faceter may have no concept of how the stone looks in each stage. With this in mind, the following cutting directions and Figure 102 are offered. The eight-sided brilliant (Diagram 1) is suggested

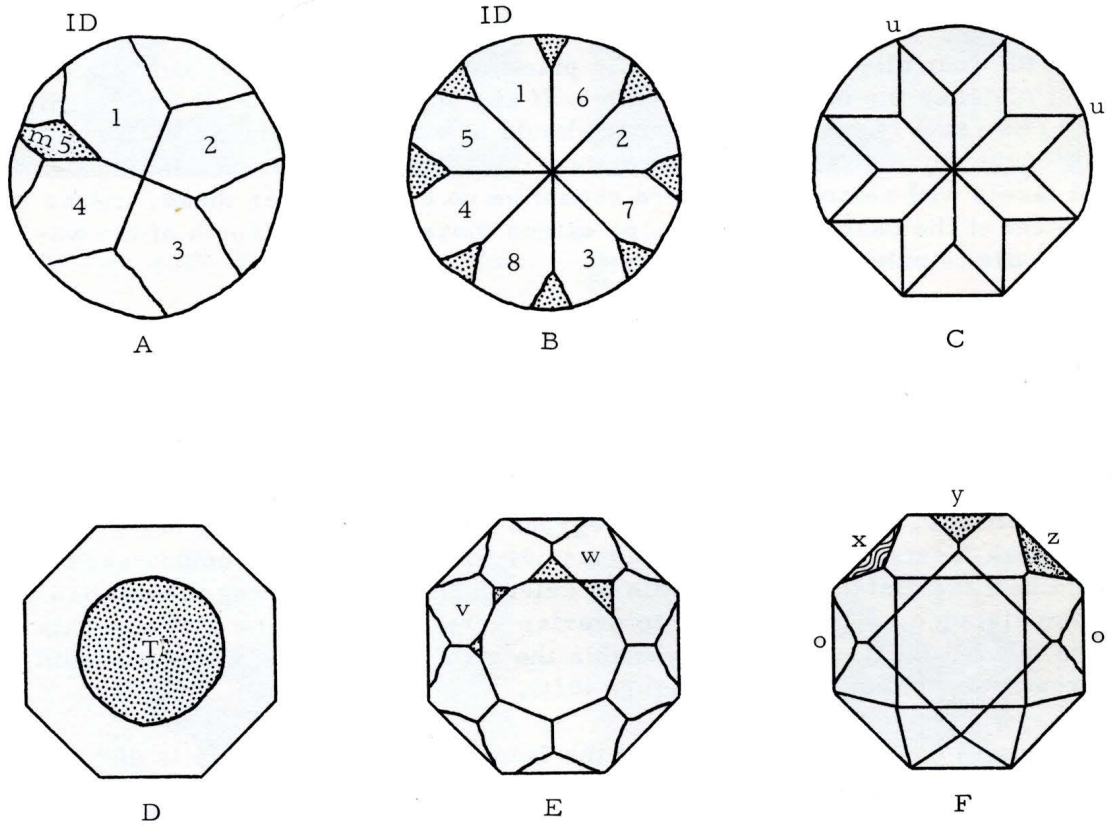


Figure 102. Cutting the Eight-sided Brilliant.

as it is simple, yet it embodies the usual types of facets found on the brilliants. If properly done the pavilion will be nicely balanced with the crown easily matched to it because of the relatively large girdle facets. The crown is similar to that of the standard brilliant with the exception of the single break facets. The single large break facets offer a good lesson in finding the correct angle in order to close the crown. The closure of the crown, by using an angle that must be found by trial, is the usual situation in the round brilliants. In other brilliant cuts break facets are small.

Cutting The Pavilion

It is best to use a piece of clear quartz or light amethyst for the first gem. It should be preformed and dopped according to the directions in Chapter IX. The

dop stick may be placed in the quill of the faceting machine without any orientation, except where the machine might take a dop stick in only one position.

Use an index head of eight-fold symmetry. Set the index pointer to the first main (ID) position. Next set the protractor at the culet angle (43° for quartz, Figure 103). On the coarse lap cut four main (M) facets on alternate asterisk (*) main settings. The faceting diagram for the eight-sided brilliant (Diagram 1) calls for the consecutive cutting of eight main facets, but for the beginner it is best to cut only four as in figure 102A. This allows one to bring these to a perfect cross at the culet. It also insures that the culet is in the exact center of the stone. This is on the assumption that the faceter is careful to be exactly on the culet angle at the end of each cut. Be certain to move slowly back and forth when cutting facets, otherwise the lap will wear unevenly.

When the four alternate mains are in place, add the other four, cutting each until it matches the others at the culet. If any one is overcut, all others will need to be recut to match. The stone should now resemble figure 102B. A small uncut portion at the base and between the mains is normal, and subsequent facets will remove it. There should be no concern over these, unless they meet at the base of the main, or extend more than one-fourth of the way from girdle to culet.

Upon finishing the main facets, change to the fine lap and recut each main slightly to remove only the coarse scratches. The order of recutting may now be consecutive rather than alternate. At the end of the fine cutting each facet should be the same size, meet at the culet, and again resemble figure 102B.

Use the same fine lap for step No. 2 -- the break facets (B). Change the index to star settings, and at an angle six degrees above the culet angle (49°) cut the eight break facets. These are cut consecutively. The points should reach just beyond half the distance from girdle to culet. The act of cutting them more than half the distance will cause them to overlap very slightly at the girdle. This will insure that all facets are entirely within the girdle line. The pavilion should now resemble the upper half of figure 102C.

Continuing to use the fine lap, drop the facet head until the angle is 90°. Index at the same star settings used above and cut step 3 -- the girdle facets. These must be the same width as the break facets, and should remove the short overlap as the result of step 2 above. The whole pavilion should resemble the lower half of figure 102C. The pavilion is now ready to polish.

Using the polishing lap and polishing compound, as is recommended in the species descriptions, polish the pavilion facets. The angle may need to be adjusted slightly away from the angles at which they were cut. This behavior is discussed in Chapter XI in the section on facet alignment. The girdle is left unpolished at this time. When the pavilion facets are polished, the stone is ready to be redopped onto another dop stick as was discussed in Chapter IX.

Aligning Crown To Pavilion

When the stone is turned onto the second dop stick, it must be aligned in the faceting machine to where the crown facets will exactly match the previously cut pavilion facets. Using the polishing lap, set the protractor at 90°, and with the dop stick loose in the quill, lay one of the girdle facets flat to the lap wheel.

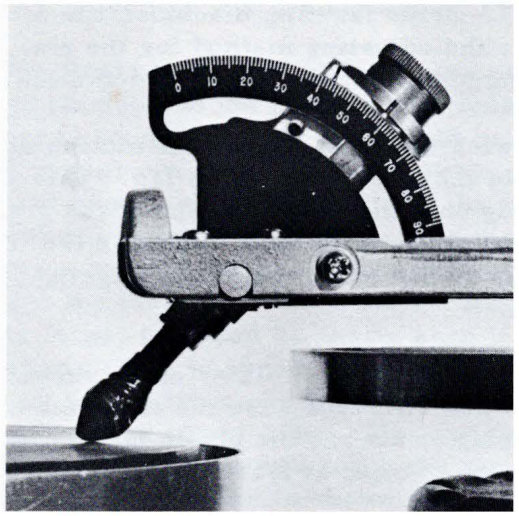


Figure 103. Angle Setting for Pavilion Main Facets.

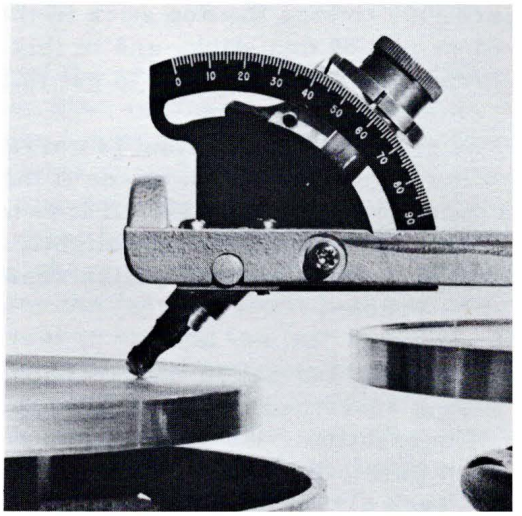


Figure 104. Angle Setting for Crown Main Facets.

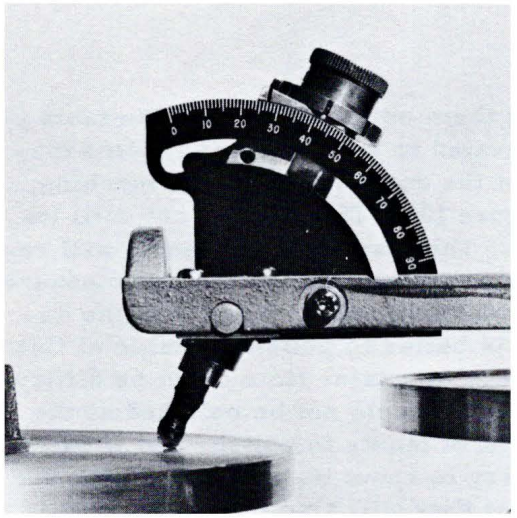


Figure 105. Angle Setting for Star Facets.

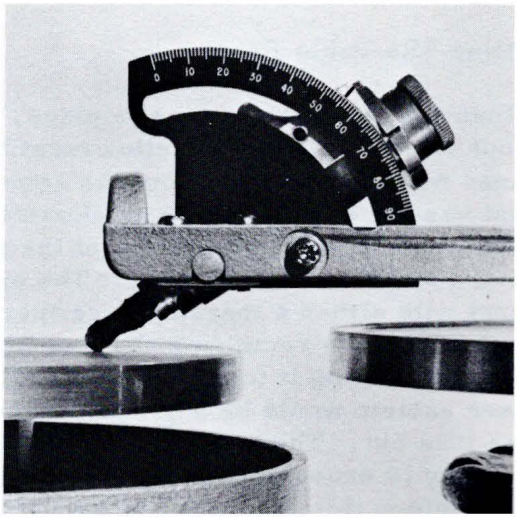


Figure 106. Angle Setting for Break Facets.

Indexing must be on a star setting--the same as used in cutting the girdle facets. When it is certain that the girdle facet is flat to the lap, as shown in Figure 100, tighten the dop stick in the quill. Some faceting machines use a keyed or pinned dop stick, and in this case, the adjusting method for the machine must be used in order to get this alignment before locking the dop stick.

To be certain the alignment is correct, swing the facet across the motionless lap a few times and check to see if the whole facet is touching the lap. This will produce a slight polish. If it is touching only the lower portion of the girdle facet, decrease the angle slightly. If the opposite is true, increase the angle. If the rudimentary polish shows only on one side, the job of aligning must be redone.

Start the lap and polish the facet for a second or two. If either of the three situations described in the paragraph above are still true, use the same methods of correction. When the polish is completely across the girdle facet, the stone is perfectly oriented--crown to pavilion. Polish at least the lower portion of each girdle facet.

Cutting The Crown

Figure 102D indicates the general appearance of the crown before any facets are placed. Begin by cutting the main facets (M) on the coarse lap. Indexing should be on main settings, with the crown angle (42°, Figure 104) being used. The main facets are cut consecutively, but care must be exercised that the girdle at the lower points of the mains is not cut away. See Figure 99, page 209. At this stage, the very small portion of girdle at the tip of the mains is the only indication of the final girdle depth. This depth will be the pattern used later to complete the girdle.

Cutting The Table Facet

When the crown mains are in place, recut them on the fine lap. The table (T) is cut as step 2. The dop stick must be elevated to zero degrees. Some machines will allow this without the removal of the dop stick from the machine; most use the 45 degree dop as shown in Figure 101. The table is cut until its width is about 60% of the width of the stone. The star facets in step 3 will remove a small amount of table. The exact size may be determined by measurements with either a measuring calipers, or a small rule. When it is the desired size, it is recut with the fine lap. It is better to polish the table at this point. Resetting it to the correct angle, etc., at a later time could be difficult. There seldom would be any reason why the table could not be polished at the time it is cut. The table is the most difficult of facets to polish, and if extreme difficulty is encountered, it may be necessary to recut it. If other facets are in place before this polishing, it may mean that they will also need to be recut. When the table is finished it should resemble the lower portion of Figure 102E. The table should be a perfect octagon.

Finishing The Crown

The next step is No. 3, the placing of the star facets (S). These are cut on the fine lap, indexing on star settings, and at an angle 15 degrees (Figure 105) less than the crown angle. The star facets should just meet their adjoining neighbors. It is best to begin by cutting a pair simultaneously, each a small amount

alternately (as at V, 102E), until they are exactly the same size--as at W in the upper portion of figure 102E. When this is accomplished, it is a simple matter to consecutively cut the remaining star facets.

The final stage is step No. 4, the placing of the crown break facets. Cutting is again done on the fine lap with indexing on star settings. The correct angle must be found by trial, but should be between ten to eighteen degrees greater than the crown angle. The breaks must be wide enough at the base to touch adjacent breaks at the lower tip of the main, and the upper tip must touch the lower tip of the star facets. This meeting must be simultaneous. To do this, make a careful trial cut at the midpoint and check to see whether it is going to reach the star or the base first. By the time the facet is about half way to the star facet, it should be easily seen if the facet is moving too fast in either direction. This is shown in figure 102F. Two untouched breaks are at o. A break that is too steep is shown at x. It will not touch the star when the base is in contact on either side. The angle must be decreased. The opposite situation is at y. The break will touch the star before it is wide enough at the base. The correct break shape is shown at z.

If a correction of angle is needed, increasing the angle will cause the base to cut more rapidly; decreasing the angle will force the tip to move toward the star facet. After making any correction, move to a new setting for the next trial cut. Use new settings for each trial cut until the correct angle is found. The partially cut facets may either be carefully cut by going back at this time, or they may be cut after the balance of the breaks are in place. In either case, they must be carefully cut as most of the material has already been removed. The crown should now resemble the lower half of figure 102F, and is ready for the final polish. After polishing the gem should be removed as outlined at the end of Chapter XI. When this is done, your first gem is completed.

Chapter XI

Polishing The Gem

FROM A COLLOQUIAL standpoint, a polished surface is a very smooth surface. This immediately points out the question; how smooth is smooth? As far as most gem cutters are concerned, they will call a surface polished if there are no scratches to be seen using a five or ten power magnifying glass under a strong light. For their purposes this is satisfactory.

To correctly define a polish, we find that the ultimate is one which has no scratches with a width exceeding one-fourth of the width of a wave length of white light. A wave length of white light measures about one-half micron, or about 1/50,000 of an inch. If we reduce this to the requirement above, no scratch on a truly polished surface can have a width greater than 1/200,000 of an inch. These figures would infer that in order to achieve such a surface, one would need to use some sort of polishing agent that would have no particle measuring over 1/8 micron. Most polishing materials are not graded in micron sizes. Diamond, in its smallest designation, is 0 to 1 micron in size. Linde A is graded to . 3 micron, and a companion product, Linde B is designated at . 05 micron.

A polished surface, such as the above, would in all probability be impossible for the amateur to attain, and also unnecessary. On the other hand, there is no excuse for faceted gems having scratches visible to the unaided eye. Some materials are very difficult to polish, and call for all the resources available to the faceter. Achieving a perfect polish on these materials is the indication of a master faceter.

THE POLISHED SURFACE

The physical aspects of a polished surface, and how it is brought about, is worthy of discussion. Sir George Beilby discovered that during polishing, the surface of gemstones actually melted and flowed as a "glassy" layer over very fine scratches. This is known as the Beilby layer. Beilby proved this by noting a certain scratch pattern, polishing the surface and then recovering the identical scratch pattern by etching the polished surface with acids. In 1937, G.I. Finch* did further work and expanded Beilby's findings. He found that polished surfaces were of two types--the one that Beilby had reported, and another that was covered with such small scratches that it appeared polished. This second type of polish had been popularly considered to be the kind of surface all polished materials exhibited. This "fine-scratch polish" exists only on materials that cannot flow as Beilby first discovered. The best example of this type is diamond.

Finch found that the Beilby layer was divided into three types. The first is the type that Beilby reported; a layer that is amorphous and much like glass. The polish on zircon and spinel are good examples. The second is where the surface layer remains amorphous, except parallel to important crystal planes, but recrystallizes much the same as the material beneath. Calcite is an example of this type. The third is where the layer forms by flowing, but always immediately recrystallizes identical to the underlying material. Quartz exhibits this type of polished surface.

The Beilby layer is very thin. It cannot be detected by a refractometer and is part of the gemstone, and is not to be considered as a separate layer. It can be readily seen, as a result of these findings, that we are dealing with an infinitesimal layer when we polish a gem. The layer is usually of slightly greater hardness than the underlying material. This probably is due to the close packing of the molecules during the time of flow under pressure. When we understand Beilby layer, it is easily seen that the size of the polishing agent particle is not important. The feature of importance is whether or not the agent will cause the surface to flow.

The faceter is only slightly interested in the polish on the surface of the diamond. Also, he is not greatly interested in what the Beilby layer does after being formed, but he is vitally interested in forming it. The three types of Beilby layer are, as far as the faceter is concerned, really only one, even though they may behave somewhat differently during and after polishing.

Polishing Agents

That which does the polishing of gemstones is some type of powder known as a polishing powder or polishing agent. Many such agents have been used for this purpose. Interestingly enough, with the exception of diamond powder, these are all oxides of various metals. Table 12 lists these according to their popularity. Linde A, the most popular of these, is a trademark for powdered synthetic corundum which is an aluminum oxide.

These agents as a group, with the exception of Linde A and diamond, are not exceptionally hard. Their action (again excepting diamond) is really not one of

* See - Gems, Webster; Vol. 1, page 357.

TABLE 12

POLISHING AGENTS IN ORDER OF POPULARITY

Linde A	An aluminum oxide, made of finely ground synthetic corundum. This product is carefully manufactured and graded to very exacting sizes. This white powder is useful for most gems, and seldom will one not respond to it. There are, and have been, a number of agents of the same material on the market. Ruby dix, ruby powder, Damascus ruby, levigated alumina, and diamontina are a few. These usually are not as satisfactory as Linde A, and vary greatly in purity and particle size. Linde A is used almost exclusively to polish the softer gem materials covered in Chapter XII.
Cerium Oxide	A rare earth oxide of a yellowish pink color. It is used extensively to polish the members of the quartz family, and usually the members of the beryl group. It is not necessarily superior to Linde A, but is more reasonably priced.
Tin Oxide	The white oxide of tin. Once very popular, but now greatly supplanted by Linde A and cerium oxide. It resembles Linde A slightly, but appears to be lumpy. The lumpiness quickly disappears when the powder is placed in liquid to make a slurry. There are a few gems that, at least on occasion, will not polish with Linde A or cerium oxide, and tin oxide usually is the answer at these times.
Diamond	Finely ground diamond powder is a necessity for corundum, and practically always for chrysoberyl. Those gems that will not fuse with ordinary polishing agents will usually polish with diamond. Diamond produces the "scratch" polish referred to elsewhere, and should be used for other than corundum and chrysoberyl only when nothing else will work.
Rouge	Red iron oxide. At one time this was the most important lapidary polishing agent, but it has been replaced much the same as tin oxide. It has almost no lapidary use today. It actually is an excellent polishing agent, but it has a tendency to stain everything a deep red color. The stain is difficult to remove from hands and clothing. This staining is greatly responsible for its abandonment.
Chrome Oxide	An excellent polishing agent under some circumstances, but the green stain is almost impossible to remove from hands and clothing. It should be used only in desperation.
Zirconium Oxide	This agent is popular with some faceters, but it appears to be identical in action to that of cerium oxide.
Tripoli	Pure quartz (silicon dioxide) in the form of remains of one-celled plants. Most useful to the faceter as a mild cutting grit, or for preparing a difficult surface before polishing.

abrasion as the term is usually considered. It is very true that under the conditions in which polishing agents are used there must be some abrasion, but if it were great, Beilby could never have observed and proved the true action. The primary act of polishing agents is to drag on the gemstone surface and generate heat. In this manner it creates the melted Beilby layer. It must be pointed out that the heat which is generated is only effective on the first few layers of molecules at the surface. If it went deeper the whole gem would heat, and troubles would ensue. This is borne out by the fact that the Beilby layer is too thin to measure. Regardless of how little of the gem is affected, this heat must be present to create a polished surface.

Diamond powder is a quite different polishing agent. It acts purely as an abrasive, with the scratches being too small to be seen without magnification. This is the reason for the careful grading to a size of less than 1 micron per particle as stated earlier. The polish induced by diamond has a greasy look which is due to the very fine scratches that remain on the surface. It is true that diamond will polish many of the harder and more difficult to handle gems, but the use of this agent should be reserved for those that will respond to nothing else.

Using Polishing Agents

The use of polishing agents is simple. They are applied in small amounts to a turning polishing lap. The word small cannot be overemphasized. The excessive use of polishing agent causes no end of troubles, some are discussed later. It is possible to do an excellent job of polishing by using a lap that has seen considerable service and add no polishing agent to it. All that is needed under these circumstances is to keep it cool by adding water. This technique may be necessary for brittle gem materials.

Most faceters apply the agent in a creamy water mixture known as a slurry. The slurry may be thick or thin, depending upon the need at hand. Polishing agents are most easily applied with a small applicator such as a brush, a swab, or lampwick. Clean fingers are sometimes used. The swab has the advantage of being easily discarded after use. The other articles must be kept clean. The hand is a poor choice, as hands touch many things, and thus can become contaminated with grit. The small paint brush is preferred. It picks up only a small amount of liquid and/or polishing agent, is easily cleaned, and can be conveniently stored in a protective container as pictured in Figure 107.

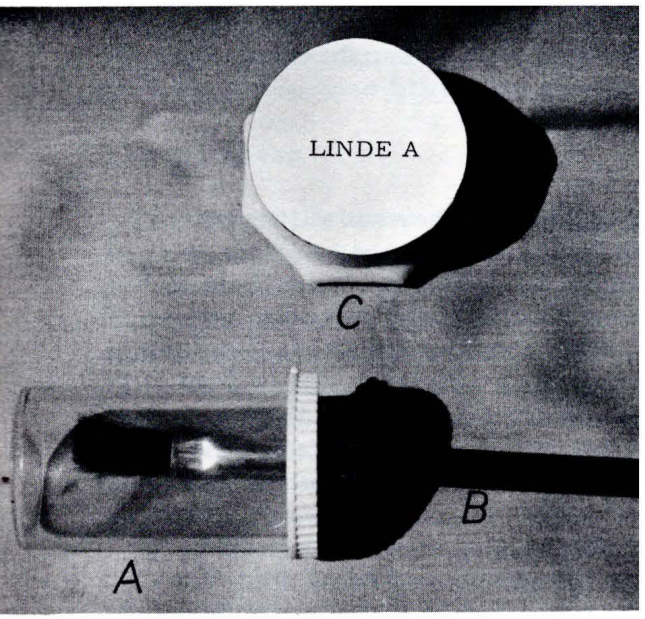


Figure 107 Equipment for Applying Polishing Agent.

The polishing agent is best used out of some flat container that can be fitted with a tight lid. A separate container should be used for each kind of polishing agent. The cosmetic jar shown is ideal. The jar can be filled to about one-fourth of its capacity with polishing agent, and enough water added to make it the

desired consistency. If the available domestic water is hard, the addition of some type of water softener, or the use of distilled water is recommended. An excellent additive to lower the surface tension of water is a drop or two of the usual household detergent. This will work wonders for brittle stones. A good rule might be to use it constantly. A jar of water with about ten drops of detergent to the quart may be made up in advance, and all water used in polishing should be taken from the prepared supply.

After a small amount of polishing agent is on a lap, it may be thinned by adding water. It is recommended that the brush be dipped more often into a container of water than the container of polishing agent. Too liberal use of the agent results in wastage, but even worse, it can cause scratches as noted later in the section on polishing problems.

At the end of a polishing job, it may appear that the lap has no agent on the surface, but after it is dry, it is surprising how much is actually on the lap. "Use polishing agent sparingly" might be the watchword.

Particles of polishing agent tend to settle in a container with the larger ones falling first. After a few minutes, the liquid in the upper portion contains only the finer particles. With some difficult gems the brush may be dipped into this upper portion to use only these fine particles. After a period of time all particles may become settled, but a gentle stirring with the brush will again float the fine particles.

Diamond Powder For Polishing

Diamond is usually mixed with kerosene and then placed in small amounts on the lap. If the faceter realizes how little of an ordinary polishing agent is needed, he will be amazed how much less is necessary to polish when using diamond. A carat of diamond powder is a very small amount. Used correctly, it should easily polish eight or ten gems of about two to four carats each. About 1/8 carat of diamond powder should be placed in a jar preparatory to use. To this, add about one-half ounce of kerosene. When diamond is needed, the brush can be placed deep in the jar and a small amount of powder caught in the tip. At other times the brush should dip only into the kerosene.

Unusable Polishing Compounds

The authors have had numerous faceters complain that they had difficulty in polishing certain stones. This was thought to be the result of either poor techniques or poor equipment, until a batch of cerium oxide was found to produce only a hazy surface on quartz. The same cerium oxide would satisfactorily polish agate cabochons with the usual methods. The same thing was observed with another batch of cerium oxide, and finally with some tin oxide. Floating the polishing agent was attempted in order to remove any larger particles that were suspected to be present as contaminants, but was unsuccessful. Each time the problem was encountered, the purchasing of a new batch was the only answer.

The answer to the problem evidently lies in some difference in the material, such as particle shape, the presence of a minor impurity, or some other idiosyncracy. At no time could contamination be proven. It is undoubtedly true that the manufacture of polishing agents is carefully controlled and carried out by reputable firms. Any packaging and handling subsequent to manufacture

should have little effect upon the agents in relation to the above behavior. It is very possible that some minor discrepancy that goes undetected in the manufacturing process results in the problem.

If a faceter experiences a constantly recurring difficulty with any polishing compound, the apparent answer is to try to purchase the same product from a different source, in the hope of buying out of a different lot produced at a different time.

Lap And Agent Combinations

Up to this point the directions have been relatively simple and easily carried out. From here on, ease and reason become obscure, at least at times. What polishing agent is used on which lap? A search of the literature will show that every lap can be and is used with every polishing agent. Someone will recommend each combination. On the other hand, others will recommend that one lap and one polishing agent is all that is needed to polish all gems.

This certainly does not indicate that there is chaos among faceters. Each is doing and recommending that which he finds to be best. The important thing this seeming chaos does indicate is that gemstones are highly variable in polishing characteristics. Each faceter is reacting according to the material at hand, the capabilities of his machine, and most important, to his habits and techniques.

It cannot be overemphasized that there simply is no combination of lap and polishing agent that will always work for any given gem material. For many years the authors polished tourmaline with great ease on typemetal with Linde A. This information was passed on to all who would listen. Finally a tourmaline was found that would not respond to this combination. Later, other tourmalines were found that also would not respond to the above combination, and some that would not respond to other previously successful combinations.

The species descriptions in Appendix I list from one to four lap and agent combinations for each gem. The greater the number of combinations offered, the greater is the possibility that the material will give trouble during polishing.

Lap Hardness

There appears to be a correlation between lap hardness and gem hardness. In general, hard stones will polish best on hard or tough laps. Diamonds are polished on cast iron; ruby and sapphire, 9 in hardness, often are polished on copper or zinc. As may be seen on Table 7, page 41, typemetal and solder are metals of medium hardness. These work well with gems of 7 to 8 in hardness. "Lucite" is a fairly hard, tough plastic and easily polishes quartz and beryl. Other metal laps are softer, and usually work well with materials immediately below 7 in hardness. When we come to gems of 5 in hardness, we find that lead or one of the softer plastics will work nicely. As discussed in Chapter XII, the very soft gems will usually respond to laps made of wax or other soft materials.

It must be borne in mind that this correlation is not absolute. Ruby and sapphire will also polish on a tin lap, as will chrysoberyl which is 8 1/2 in hardness. The discrepancies are most apparent in the harder gems. Those of medium hardness vary somewhat less, but the soft gems will seldom respond

to a hard or medium hardness lap, except at very slow lap speeds. At ordinary lap speeds (300 to 500 rpm) the progression of hardness shown in Table 7 can ordinarily be used as a guide when polishing difficulty is encountered. If polishing difficulties continue, the use of softer laps rather than harder ones would be the logical choice.

The Polishing Technique

Each facet must be returned to the same angle and index setting used in cutting. The machine is operated in the same manner as in cutting the facet, with the exception that greater pressure is needed to polish. Most important, polishing must be done while the stone is moved from side to side across the lap. This action was recommended for cutting facets to make the lap wear evenly, and holds here. The prime reason during polishing is to keep surface irregularities of the polishing lap from inducing grooves and furrows into the facet surface.

The amount of pressure will vary slightly with facet sizes and from mineral to mineral, but in all cases it will be far greater than the pressure used in cutting. Polishing removes a small amount of gemstone, and heavy pressure will remove more than light pressure. It is important that the amount of pressure be held reasonably constant for any given stone.

Polishing The Whole Facet

The first facet of a row should be polished carefully. A very light touch to the lap should be made to determine if the whole facet is touching the lap. It may come as a surprise that many facets will not polish at exactly the same angle as cut. This will be true even when all work is carefully done, and the cutting angle is very precise. The same will be true for indexing; some facets may appear to have twisted slightly. The answer to this is simple; the surfaces of laps vary from one to another, and perfect matching is a rarity. The cure to these situations is also simple. Change the angle slightly for vertical discrepancies, and use the cheater for horizontal adjustments. If the polish is appearing only on the girdle end of the facet, decrease the angle. The opposite is true for a polish too high on the facet. Because of these situations, it is imperative that the first facet of a row be carefully started. Each subsequent facet of a row should also be carefully watched, as many times there are considerable differences within a facet row.

The sensitive faceter will note any irregularity of facet to lap relationship by the sound. When the facet is perfectly flat to the lap, the action is quiet. If the facet is not flat, a corner or thin edge is in contact, and there is a tendency toward a sharp sound. The sound is greater in intensity with greater irregularity. At times, in spite of all care, the wrong index position may be used, and this sound will be an instant warning.

When the facet has been set exactly flat to the lap, polishing can begin in earnest. Polish continuously until it is thought that the facet is completely polished --then inspect. All inspections must be preceded by a thorough cleaning of the facet surface. Some sort of tissue is excellent for this purpose. If the facet is not completely polished, more work will be necessary. Try to judge the time needed to polish a facet of a certain size, and polish for this predetermined time without interruption. Frequent inspections are time consuming, and tend

toward problems as noted below.

It is imperative that the lap not dry out while polishing is in progress. The lap need not be excessively wet, dampness is all that is necessary. Before each polishing operation, water or agent must be applied, and water must be added during long polishing runs.

Be certain that each facet is polished before going on to the next one. If a facet is later found to be only partially polished, duplication of the exact position may be difficult. Do the job completely when the facet is flat to the lap. Use good magnification, and a bright light from a small source. A small lamp gives a high intensity point of light which is desirable, and radiates less heat, which may be important for comfort.

THE POLISHING SEQUENCE

Just as in cutting the gem, there should be a polishing sequence from one facet row to another. This is true for both pavilion and crown. Many faceters state that all polishing should be "toward the girdle". In general, polishing of the pavilion should begin at the culet and progress row by row toward the girdle. For the crown, a like progression, from table toward the girdle is usually true. Seldom is it mandatory, and on occasions the polishing order may need to be altered, or even reversed.

There are a number of reasons why it is best for a polishing sequence to advance toward the girdle. These are based upon the assumption that polishing is carried out as in Figure 97, page 205, in which the lap is rotating from the girdle toward the bulk of the stone.

Let us assume that we are reversing the sequence and are working on the pavilion. We have polished the break facets, and are polishing the main (culet) facets. The angle between the two rows is two degrees. This means that a very small wedge-like space exists between the lap and the polished break facet. This space is an excellent place for polishing agent to accumulate and dry, and through aggregation and flow, it may scratch the polished surface. A second situation, valid on the metal laps, is that there is a tendency to shave off some of the lap surface with the leading edge of the facet being polished. This metal and the dried polishing agent will often adhere very tightly to the polished facet. Both are literally packed into this wedge. It is often difficult to remove these adhering particles without damaging the facet.

If we would reverse the polishing direction, as well as the polishing sequence, the results would be different. We will find that if metal and agent adhere to an unpolished surface, they are quickly removed during the subsequent polishing process. If we return to the first situation and compare the two methods, we find that polishing agent will also pile up in the small wedge of space behind an unpolished facet, but it does not tend to scratch; if so, it is not noticeable, and is removed during polishing.

Now for the exceptions of the sequence rule. At times a stone will not polish with the wheel moving from the girdle to the mass of the stone. One of the best cures for this problem is to reverse the direction of polishing. This is best done by placing the stone on the opposite side of the lap. Now the lap is moving from the mass of the stone, toward the girdle. It is almost mandatory that the

long culet facets of the step cuts be polished in this manner. If not, chips will be taken off the culet with the polishing wheel. When reversal is necessary, the culet facets should be polished last. This will remove the problem of particles of metal or polishing agent adhering to the polished facets.

In some cases, such as the mixed cuts, the order of polishing is far from consecutive, and the cleaning of bits of metal and dried polishing agent from some facets may be necessary. Alcohol and a soft cloth will do the job. The type of scratching noted above does not often happen with the mixed cuts as they seldom have adjoining facets at closely adjacent angles.

Polishing The Table

Generally, the table is cut and polished after the largest facets of the crown are in place, and before the smaller facets are cut. Many faceters start a gem by cutting and polishing the table. It is then very carefully oriented to be exactly at right angles to the future vertical axis. The next step is to cut the crown. Even though this method is not recommended, it has some merit. The table is, almost without exception, the most difficult of any facet to polish. If it is done first, the most difficult facet is completed. This does not outweigh the factors of finding and completing correct pavilion angles as outlined in Chapter VII. If a faceter wishes the best gem possible, the table must be cut and polished late in the process.

If the cutting sequences herein are followed, the point at which the polishing of the table is suggested will give the faceter enough latitude to compensate for any recutting. There is no known method, as far as the authors are concerned, to insure trouble free polishing of the table. Even if it is done first, many of the difficulties still appear.

The act of polishing the table puts a strain on the faceting machine. This is the result of two factors. First, the facet is large, and great pressure is needed to accomplish the polish. Second, the dop stick must be in a vertical position which helps to induce chatter, especially on the metal laps. This difficulty is most apparent in the larger stones. Stones below three carats show it infrequently. Gems of from five to ten carats usually give some trouble in polishing. If the lap is well scored, and the faceter is certain of the correct amount of polish compound and wetness of the lap, his troubles will be minimized. The exact amount of pressure is also very important. All gems do not give trouble in polishing the table, but those that do make one apprehensive when the time to polish the table approaches.

Hand Holding The Gem

The difficulty of polishing table facets of large gems may be overcome by removing the dopped gem from the quill or 45^{o} dop and placing it on the lap while holding it in the hand. This is possible with stones having a table of about seven millimeters or larger. The stone is carefully placed on the turning lap so that the table is perfectly flat to the lap. The necessary amount of pressure may easily be exerted with little chattering or other ills. The stone and dop stick must be held securely, with most attention being paid to holding the stone. The most steady position is that where the fingers are close to the lap, and the use of both hands is advisable. Some practice will be necessary to be able to set

Figure 108. Hand Holding a Gem to Polish the Table.

the table flat to the lap, and keep it as shown in Figure 108. Rectangular shaped stones are easier to do with this method. It would be wise to gain experience by first trying to hand hold a rectangular stone.

This method offers much latitude in working the table surface. The stone may be rotated while the polishing is in progress; a motion that appreciably helps the work. This is seldom possible when the stone is held by the machine. If the table surface is a bit irregular, the stone may be tilted very slightly to polish the irregularities. This does not produce a perfectly flat table and is to be avoided if possible.

POLISHING DIFFICULTIES

Any difficulties encountered in polishing are usually due to one or more reasons. The least of these is grit contamination of either lap or agent. The usual practice of many faceters, when they encounter scratches, is to wash the lap and make a new supply of polishing agent. There is nothing wrong with cleanliness, but in this instance it rarely solves the problem.

Aggregation And Flow

The greatest and most vexing difficulty encountered in polishing is aggregation and flow. All polishing agents have the tendency to accumulate in front of the leading edge of the facet being polished. Whether the slurry is thick or thin makes little difference as to whether or not it accumulates, but a thick slurry tends to pile up in large amounts. There is a great force being exerted at the leading edge of the facet; and this, plus any vacuum that may be present under the facet, tends to force the polishing agent under it.

When agent is forced under the facet, it usually is in fairly large amounts, and it is compressed between the lap and the facet. This compression forces the particles to accumulate into an irregular ball. While in this condition, the particles rub against each other. This rubbing under great pressure causes the individual particles to melt slightly on their surfaces. They flow slightly and fuse into a semi-solid mass. This mass now acts like a single piece of grit.

This effect leaves unusual scratches. Some may start well into the facet, some distance from the leading edge, and terminate before the trailing edge. Others may begin at the same point, but continue to the far edge of the facet, and scratch an adjoining polished facet. At other times, scratches may begin at the leading edge, and terminate before reaching the trailing edge.

These irregularities are explained by the fact that the aggregation may not become effective until it is well under the facet, and may or may not be broken

up before it is out from under the facet. The scratch on the adjoining facet is a carry over of the effect. The scratches as a result of aggregation and flow are not usual scratches; they are deep gouges. Further attempts at polishing will seldom remove them.

Aggregation and flow has a pronounced tendency to occur just at the point where the polish is nearly complete. At this point the facet is at a very close proximity to the lap, and a partial vacuum easily forms under the facet. The vacuum is finally broken by the polishing agent being pushed and pulled under the facet. Many faceters have bemoaned the fact that in their quest for perfection, they took one more try to remove an infinitesimal scratch, only to discover a deep scratch. It is by no means inferred that the last scratch should be left on a facet as a matter of routine, but there are certainly times when one cannot escape this course.

When aggregation and flow appears, the first remedy might be to reduce the consistency of the polishing slurry. This will at least lower the potentiality for it to occur. The action that probably has the greatest effect is to change the direction of movement of lap across the facet. A complete reversal, that of moving to the other side of the lap, is best. With some types of machines this is not possible, but any change in direction may help. Quite frequently, a small chip or irregularity of the leading edge of the facet tends to funnel the polishing agent under the facet. The change in direction will usually remove the ability of the offending irregularity, or at least minimize it. If change of direction does not correct the problem, try a different polishing agent, or a different lap and polishing agent. Variation of pressure, usually less, or moving to the center of the lap (which is actually lowering lap speed) may help.

There is no question that at such times at this, the faceter is groping for a solution, and determination is about all he can rely on to help him. In times of utter desperation, it may help to put the stone aside for a few hours or days. Surprisingly, the second try may be completely successful. This last may seem illogical, but it has worked for many. It stands to reason that at a later time many conditions may have changed, including the disposition of the faceter.

One bright note to offer here is that aggregation and flow seldom occurs on small facets on the body of the stone. The effect is most usual on the large facets, especially the table. If it does show on a small facet, it is probably parallel to a cleavage plane or some other plane of inconsistency. When this is the case, the problem will usually appear again on the opposite side of the stone on a nearly parallel facet or facets.

Another behavior of aggregation and flow is common. It appears as lines or grooves across the facet, and results in a completely polished, but undulating surface. This nearly always is the result of using too thick a slurry. Thinning the agent, or better yet, adding much more water than agent to the lap will usually cure the problem.

An effect which resembles the aggregation and flow effect immediately above is due to the irregularities of the lap surface. Scoring of the lap makes the surface irregular. This scoring is a great boon in helping the polishing agent work, but these irregularities will polish small grooves on the facet if the stone is held in one position on the lap. The correct polishing technique is to slowly move the stone to and fro across the lap. Grooves will not appear with this motion.

There may be times when a rapid movement across the lap is necessary. Grooving will be more pronounced with soft materials.

Polishing A Facet On A Cleavage Plane

In spite of all precautions taken at the time of preforming, on occasion, the faceter will find one or more facets of a stone to be nearly parallel to a cleavage plane. As noted previously, this will be a greater possibility with materials having a number of cleavage planes. If the table facet is found to be nearly parallel, the problem is great, but not insurmountable. If one or more of the small facets on the body of the stone are involved, it is usually possible to get at least a reasonable semblance of a polish.

First determine which way the cleavage plane dips from the facet surface. The very small wedge-shaped chips will be the clue. Any polishing should be directional, as shown in Figure 97, page 205. After the correct polishing direction is determined, it should not be changed. If it is possible to reduce the speed of the lap wheel, by all means do so. A slow speed will help immeasurably to obtain a polish, but it will greatly increase the time necessary to accomplish the job.

Regardless of the lap speed, try the softest lap on hand. Table 7 lists polishing laps according to hardness. If the stone is 5 or better in hardness the lead or vinyl lap might be a good one to start with. Linde A is probably the best choice as a polishing agent. Place the facet in contact with the turning lap, using a very light pressure and slow short sidewise movement. There is no need for frequent inspections as the progress will be slow.

If the stone is below 5 in hardness, or if the normal soft laps do not work, use a wax lap. The authors once took a preformed fluorite to facet for a customer. It was not realized at the time that the table had been placed on one of the cleavage planes of the piece of rough. It was polished, however, by using a wax lap at 50 rpm. The job took about three hours. It was not necessary to tend it for the entire time. Patience and ingenuity will be necessary to polish these troublesome facets.

Variation In Gem Materials

The real reason for polishing difficulties lies with the gem materials themselves. There is no such thing as a chemically pure gem to be found in nature. Synthetics may be nearly chemically pure, but even they, because of introduced coloring matter, give some trouble. All natural gems carry greater or lesser amounts of impurities. These impurities may account for a highly desirable color, so it is not surprising that troubles ensue.

Two pieces of the same mineral from the same mine may have different impurities, and show different cutting and polishing characteristics. Even though these impurities may be microscopic in size, they can have profound effects. We are confronted with variations in the same species of gem from different localities, and also a variation within specimens from the same locality. We must expect cutting and polishing characteristics to vary.

There may be times when a combination of polishing lap and agent will not work for the gem as recommended. This could be due to the characteristics

noted above. The remedy for any facet or facets staying hazy and refusing to polish may be simple; try another combination of lap and polishing agent. In many instances, certain gem materials, such as zircon, are reported to cut scratchily. It is possible that some will not cut on a copper lap. This is ordinarily due to the gem material containing many fine particle impurities that may be of different hardness or toughness. These particles have a tendency to collect bits of copper from the lap, which are packed into the scratches and pits normally on the facet surface. Such a stone, if it can be cut, may be fully expected to give polishing difficulties.

There are times when it may be found advantageous to let the lap polish when nearly dry. This is a tricky practice, but it can be done if necessary. At other times, the polishing agent may need to be thick and pasty on the lap, in spite of the previous discussions. Obviously, aggregation and flow could not be part of the problem here. Many other conditions of dryness, excess of water, thickness of slurry, etc., may be found necessary at times, in spite of rules, admonitions, or advice to the contrary. The clever faceter quickly recognizes trouble and keeps in mind the possible solution.

The polishing of flawed stones, if the flaw reaches the surface, will usually result in difficulties. The most common problem is that polish marks, again the aggregation and flow effect, will appear just beyond the flaw. If the flaw is deep, or an actual crack, polishing agent will enter it. Neither of these problems can be easily corrected. In the case of the first, the flaw is always there to help aggregation and flow, and reversal of direction will simply reverse the polish marks. A very thin slurry will sometimes help. The filling of the open crack usually results in an unsightly inclusion in the gem just below the surface. The best remedy for these problems is not to attempt cutting gems with surface cracks.

A perfectly polished gem is a marvelously beautiful thing. To strive for this always is an admirable aim. It must be admitted, however, that this cannot always be achieved. Many gemstones, such as quartz, beryl, and tourmaline, usually polish with ease and rapidity. These the faceter can quickly master and be proud of. There are, on the other hand, many materials that sometimes resist every effort to achieve an acceptable polish. Opal, peridot, and apatite are common gems that display this characteristic. Some of these, such as peridot, do not show the same problem at all times. One stone may give no trouble whatsoever, raising the hopes of the faceter that his technique is such that he has mastered it. When he hopefully tries another, he may have nothing but difficulties. The gem may scratch and gouge at the slightest touch. The literature contains more advice and ideas on how to polish peridot than any other gemstone. All these ideas work sometimes, but none of them work all the time.

No faceter desiring to cut a variety of gems can resist these troublemakers. When he makes up his mind to do them, he will simply have to cut them, with or without scratches, and enjoy them. If he can bring himself to this, he will then want to go further and try the host of rare and unusual gem materials. The next chapter was written especially for him.

REMOVING THE FINISHED GEM

When the gem is completely polished, it is removed from the dop stick. Heat is applied to the dop stick about one-half inch below the limit of the wax. When

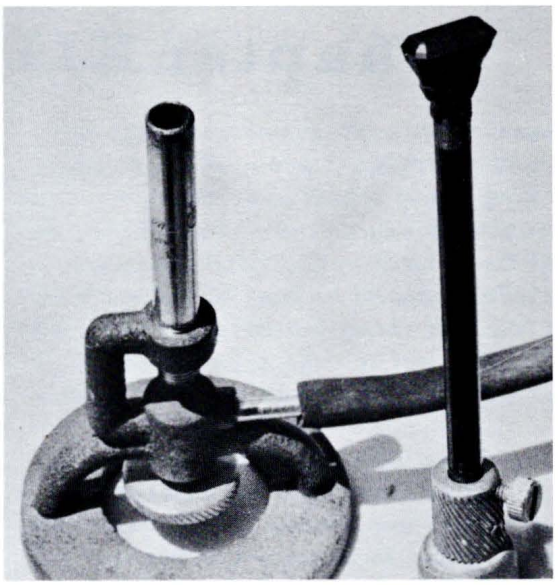


Figure 109. Removing a Finished Gem from the Dop Stick.

the wax is soft, the gem will begin to sag. At this point the dop stick is turned to a vertical position with the gem upward as shown in Figure 109. A few seconds in this position will soften the wax adhering to the gem. It is then pulled free from the wax with the fingers. Never use metal tools, as chips are the usual result. Any wax that may adhere to the gem is pulled free with the fingernails during the time the gem is still warm. If all the wax is not removed before the gem cools, do not reheat.

The gem should be allowed to further cool for a few moments, and then be placed in a small jar of alcohol. All remaining wax and shellac should be dissolved in fifteen minutes to an hour, depending upon the amount of wax present.

Chapter XII

Soft Materials

GEM MATERIALS COVERED in this chapter are difficult to handle in more than one respect. Others are troublesome, but if they pose only one type of problem, they are not included. The gems that are troublesome in two or more areas are grouped on the basis of hardness, and include those of six or below on the Mohs scale. Hardness is not the only criterion with which to separate the materials that offer much difficulty from those that do not, but surprisingly, it is a quite good indicator. In actuality, the difficulties increase at almost the same rate as the hardness decreases. Low hardness in itself is usually a problem in faceting. At the same time, as hardness decreases, other problems such as brittleness (fragility), cleavage, and heat sensitivity are added to it. Two or more of these combine to give polishing problems, and often these combinations give difficulties in cutting.

GROUPED ACCORDING TO HARDNESS

For ease of presentation, these minerals are placed into three groups based on hardness; Group One, 5 to 6 in hardness, shown in Table 13; Group Two, 3.5 to 5 in hardness, Table 14; and Group Three, 2 to 3.5 in hardness, Table 15. Group One contains the gems that usually offer few problems. Many faceters will no doubt be surprised to find some of their old favorites in this group. Regardless, each of these have at times given a number of faceters some difficulties. Notes on these may be found in the species descriptions in Appendix I.

The possible areas of difficulty lie in some of the physical characteristics of

these minerals. Hardness has been discussed, and listed with this are fragility, heat sensitivity, and cleavage. Hardness in all cases is reported simply as the hardness number.

The tendency to fracture (brittleness and its opposite, toughness) is listed as fragility. The word fragility is used here as a key to a wide band of possibilities. It is obvious that a tough gem is not fragile, whereas a brittle one is. On the other hand, where does brittleness stop and toughness begin? Somewhere on the scale brittleness grades off into toughness, and here the word fragile or fragility would tend to become invalid. The gems under immediate consideration, for the greatest part, will not fall into the tough classification. For our purposes here, a gem of low fragility can be considered as tough, while a gem of high fragility can be considered as brittle.

Some gem materials will break or cleave with a sudden change in temperature. This is listed as heat sensitivity. A gem of low heat sensitivity is one that may be heated under almost any situation, even with an open flame. The greatest heat sensitivity (extreme) indicates a gem material that cannot tolerate much more than the normal day to day temperature changes.

The tendency for a gem to cleave from mechanical shock during any stage of the faceting process is listed under cleavage problems. This cleavage listing should not be confused with the problem of orientation that was discussed earlier. It is true that the lack of correct orientation will compound cleavage problems, but many gem materials show the ability to cleave during the cutting process regardless of orientation. This is expecially true of minerals having the larger numbers of cleavage planes. Most of these are among the soft gem materials.

The problem areas of fragility, heat sensitivity, and cleavage are reported in the following ascending catagories: none, low, moderate, high, and extreme. Any listing for low can usually be ignored. A listing for moderate calls for reasonable care. The listing of high denotes a problem, and care should be exercised. Any material having a listing of extreme in any category will give serious difficulties in that area, and could easily have an effect on the other categories. Two or more extreme listings indicates a gem material that is very difficult to handle.

Most faceters experience a real exhilaration upon successfully completing a member of the three following groups. Some materials such as sphalerite, proustite, rhodochrosite, and calcite produce very beautiful gems that are certainly objects of which to be proud, as they can easily be the indication of a master faceter. In order to achieve this distinction, one must cultivate and thoroughly master three important techniques--infinite patience, a light touch, and an unhurried attitude.

Tables 13, 14, and 15 cover the problem areas of each of the groups of soft gem materials. With each table is a general discussion of each group. The balance of this chapter is devoted to the specialized equipment and techniques needed to produce gems from these materials.

TABLE 13 - Group One

MINERALS FIVE TO SIX IN HARDNESS

Mineral	Hardness	Fragility	Heat Sensitivity	Cleavage Problems	Cutting Lap	Polishing Lap
Actinolite	5-6	low	low	extreme	ex.fine	tin/lead
Beryllonite	5½-6	low	low	high	fine	tin/lead
Braziliante	5½	low	high	high	medium	"lucite"
Datolite	5-5½	moderate	low	low	medium	"lucite"
Dioptase	5	moderate	low	high	ex.fine	tin/lead
Kyanite	4 & 7	low	high	extreme	ex.fine	tin/lead
Natrolite	5-5½	extreme	moderate	extreme	ex.fine	"lucite"
Obsidian	5-6	extreme	high	none	medium	"lucite"
Opal	5-6½	high	moderate	none	medium	tin/lead
Rhodonite	5½-6½	extreme	moderate	extreme	ex.fine	tin/lead
Smithsonite	5½	low	moderate	moderate	fine	lead
Tremolite	5-6	extreme	moderate	extreme	micarta	wax
Willemite	5½	high	low	moderate	medium	"lucite"

All ratings are for the most extreme cases; it is very possible that specimens of some minerals will be found to have lower ratings. The cutting laps listed are to be considered the safest maximum grit size. Some specimens might respond to a coarser lap, but the risk is not worth the small amount of time saved. Certain specimens may not polish on the lap indicated. The species descriptions in Appendix I may list others. Linde A is the usual polishing agent, but the species descriptions may also list others.

Group One - The Least Difficult

As may be seen from Table 13, most of this group is brittle and exhibits a cleavage problem. If these two characters are not combined in the same mineral, then one of these is combined with a heat sensitivity. There are a few minerals listed that have only one such problem area, and perhaps it might appear they should not be included. Even though they show only moderate brittleness, this coupled with low hardness offers difficulty in both cutting and polishing. All minerals listed in Group One will polish under normal circumstances with the lap listed.

The gem materials of Group One offer the greatest difficulties in either preforming, dopping, or cutting; the result of either brittleness or cleavage. They should be handled very carefully to avoid all shocks. Cutting for the most part should be done on the fine or very fine laps--the latter preferred. Attention paid to this cutting situation will usually be well repaid with a fine gem.

Most members of this hardness group will polish with comparative ease on a metal lap, with tin/lead evidently the best. The few that may need plastics or wax under normal circumstances, will respond to a metal lap at slow speeds as discussed later in this chapter.

TABLE 14 - Group Two

MINERALS THREE AND ONE-HALF TO FIVE IN HARDNESS

Mineral	Hardness	Fragility	Heat Sensitivity	Cleavage Problems	Cutting Lap	Polishing Lap
Apatite	5	moderate	high	moderate	medium	vinyl
Apophyllite	4½ - 5	high	extreme	extreme	micarta	tin/lead
Aragonite	3½ - 4	high	moderate	moderate	ex.fine	wax
Azurite	3½ - 4	moderate	low	low	fine	wax
Colemanite	4 - 4½	high	high	high	ex.fine	wax
Cuprite	3½ - 4	extreme	extreme	moderate	ex.fine	wax
Dolomite	3½ - 4	moderate	extreme	extreme	ex.fine	wax
Fluorite	4	low	low	extreme	fine	lead
Ludlamite	3½	low	high	extreme	micarta	wax
Magnesite	3½ - 4½	moderate	extreme	moderate	ex.fine	wax
Rhodochrosite	3½ - 4½	moderate	extreme	moderate	ex.fine	wax
Scheelite	4½ - 5	high	none	moderate	fine	wax
Siderite	3½ - 4	high	high	extreme	ex.fine	wax
Sphalerite	3½ - 4	moderate	low	high	fine	wax
Stibiotantalite	5½	moderate	moderate	moderate	fine	wax
Witherite	3 - 4	moderate	low	low	fine	wax
Zincite	4 - 4½	high	low	low	fine	tin/lead

It must be pointed out that these minerals are usually variable, and some specimens may respond quite differently than the table indicates. Polishing is done almost exclusively with Linde A, but other agents may be indicated in the species descriptions.

Group Two - The Moderately Difficult

As a whole, the problems found in Group One are present in Group Two, Table 14. To these are added new problems in at least one other area, or these previous problems are now high or extreme. The combination of problem areas results in difficulty in polishing and usually in cutting. These are a direct effect of low hardness combined with high fragility. Unless the faceter is certain, Group Two should be cut on the very fine lap. The possibility of shock is greatly lessened with the smaller grit sizes. It is surprising how little shock is necessary to force off a chip or open a cleavage, even on harder minerals.

Most members of this group will need a wax lap for polishing. This treatment is usually successful, but the wax lap will tend to round facet edges. Faceters that can lower the speed of the polishing lap will find that those materials that normally need wax to polish, will be able to achieve an excellent polish on a tin / lead or tin lap at a speed of about 100 rpm or less. This is especially true of the carbonates, the most of which are members of this group. The use of slow polishing speeds is covered later in this chapter. Calcite, another of the carbonates, is a member of group three, and will not ordinarily respond to slow speed on a metal lap.

TABLE 15 - Group Three

MINERALS BELOW THREE AND ONE-HALF IN HARDNESS

Mineral	Hardness	Fragility	Heat Sensitivity	Cleavage Problems	Cutting Lap	Polishing Lap
Anglesite	2½ - 3	extreme	extreme	moderate	micarta	wax
Anhydrite	3 - 3½	extreme	extreme	extreme	micarta	wax
Barite	2½ - 3½	extreme	extreme	extreme	micarta	wax
Calcite	3	low	high	extreme	fine	wax
Celestite	3 - 3½	high	moderate	extreme	ex.fine	wax
Cerussite	3 - 3½	extreme	extreme	high	fine	wax
Cinnabar	2 - 2½	extreme	extreme	moderate	micarta	wax
Crocoite	2½ - 3	extreme	extreme	moderate	micarta	wax
Kurnakovite	2½	moderate	high	moderate	fine	wax
Phosgenite	2 - 3	moderate	extreme	high	micarta	wax
Proustite	2 - 2½	extreme	extreme	extreme	micarta	wax
Sulfur	1½ - 2½	extreme	extreme	extreme	micarta	wax
Vivianite	1½ - 2	low	high	extreme	micarta	wax
Wulfenite	2½ - 3	extreme	extreme	moderate	micarta	wax

The members of this group as a whole are very difficult to cut and must be handled with extreme care. Many specimens may show characteristics higher or lower than indicated. Wax laps with tripoli may be substituted for micarta and loose grit.

Group Three - The Very Difficult

When a faceter wishes to cut a very unusual gem, he dips into Group Three, Table 15. These minerals offer combinations of most of the problems of Groups One and Two, plus others. Preforming must be done with great care. A cold dopping cement is mandatory. The handling of any of the members of this group must be done only when the faceter has full confidence; it is not a time for guessing. Proceed only when it is reasonably certain that there is a good chance of success.

Some of this group are safely cut on the very fine lap, the balance may be cut on a micarta lap with loose grit as previously outlined. Some are so touchy that they must be cut and polished in one operation using Linde A on a wax lap. Regardless of the kind of lap used, all call for a light touch and careful directional cutting. The directional cutting calls for careful orientation of each facet in order that the direction of movement of the lap is away from the cleavage rather than toward it. This is the usual treatment for any material with an easily opened cleavage.

Polishing of any member of this group is usually very difficult, and some have been found never to take a good polish. Seldom will the faceter be able to use other than a wax lap. Even this favorite for soft materials will show some strikingly peculiar behaviorisms.

Preforming The Soft Materials

Any of the members of the three groups should be preformed with great care. Group One will call for the least special attention, while Group Three will need the most. The grinding wheel must be perfectly true and flat. Any bumpiness will quickly open a cleavage or take off a chip. This happens with too great a frequency on perfectly true grinding wheels. Take plenty of time and use all precautions. When in doubt, put the rough aside until the job has been considered from all aspects.

The point of the culet of the round brilliants and the chisel-edge culet of the step cuts chip easily during preforming. It is usually best not to bring these to the final point at this time. Soft materials cut rapidly on the faceting lap, and the time necessary to bring the pavilion to the correct point will be short.

Dopping Heat Sensitive Materials

All three groups contain heat sensitive minerals. Group One contains the least, with none of them extreme, but some are listed as high. Group Three is made up almost entirely of minerals in the extreme class.

Low sensitivity minerals may be dopped with ordinary dopping wax by the usual methods. Those of moderate sensitivity may be dopped using care as noted in Chapter IX. A wax of lower melting point may be advisable. Some cabochon dopping waxes melt at about 150° Fahrenheit, and it is possible to get a wax from a dental supply house that will melt at about 100°. These low melting point waxes will work, but there is the possibility of heat during polishing, softening them as discussed in Chapter IX. Any moderately heat sensitive gem material, regardless of the wax used, should not be subjected to any sudden change in temperature.

Cold Dopping Cement

Gem materials having a high or extreme heat sensitivity are vastly different. No heat should be applied to them. The only answer is to use a cold dopping cement. A few cements are suited to this job. The best are the plastic glues. The common "model airplane glue" (cellulose acetate) is fairly satisfactory. A product known as Glyptal, but also sold as Stronghold Cement is excellent. These cements adhere fairly well to the rough surface of the gemstone and the dop stick; are tough, and are easily removable with solvents such as acetone or methyl ethyl kétone. These are no panacea, and offer some problems. Special care is needed to keep the preform correctly oriented on the dop stick during the initial setting period of about one-half to one hour. During this time the preform may easily move out of position. Before cutting can begin, the cement must be completely set. A period of about twenty-four hours is necessary, and during cool or humid weather the period may be longer. If the cement is not completely set and hard, it will be flexible, and will allow the stone to move out of alignment during the cutting process.

When completely set, the plastic cements are somewhat flexible. This is most noticeable when the stone is dopped on the table. There is a tendency for the stone to move out of alignment, especially under the pressure of polishing. When the stone is dopped on the pavilion, the problem is practically non-existent. These cements offer a problem in adhering to the stone. They do not

adhere well to a rough surface, but make a surprisingly good bond to a polished surface. The lack of bonding to a rough surface is due to the entrapment of tiny air bubbles within the pits and scratches of the preform, thus reducing the contact between cement and stone. This can be corrected in a great degree by making as true a preform as possible, and grinding it on a very fine wheel. Here is an excellent use for the extra fine commercially charged lap.

Redopping is also a problem. It is a simple matter to place cement on the pavilion and allow it to set with the proper dop stick in contact, using the redopping fixture. Softening and removing the cement from the first dop stick is difficult. Solvents work best in a closed container. This would remove the stone from both dop sticks. The best method is to carefully wrap the cement needing to be removed with a small strip of absorbent cloth. Cotton flannel is best, synthetic fibers may dissolve in the solvent. When the cement is wrapped, saturate the cloth with the solvent. A number of applications are needed, and care must be exercised to keep the solvent away from the newly applied cement. Carrying out this operation with the dop sticks vertical and the new cement uppermost is the safest. Unless the stone is quite large, a few applications of solvent over a period of about a half-hour will break the bond. Removal of the gem after it is completed is easy. Simply place the dopped gem in a covered container of solvent, and let it stand until free. Do not pry it off.

Some lapidary supply houses offer cold dopping cements that were developed for use in diamond sawing and are insoluble in oils. They are soluble in water and will slightly soften in the water used as a lap lubricant, but will readily dissolve after the gem is finished, by using warm water.

Some faceters have successfully used a cold dop made with the cellulose acetate cement and cornstarch. A mixture of the consistency of light putty is applied to stone and dop stick. It has the advantage that it is easy to handle, and will not drip. It must have approximately the same period of time to set as the pure cement. It can be removed with the same solvents and under the same conditions.

The use of catalyst-setting polyester resins for cold dopping is fairly successful. This holds well but is a difficult material to remove. After setting it is not flexible as are the other plastic types. There are solvents on the market designed to remove epoxy glues, and these solvents will remove the polyester resins equally well. They do not readily dissolve resins, but break them down, and while doing so, cause some swelling that may set up some undesirable stresses. Cold dopping, at best, is always a problem, and the faceter will either accept one of those offered above, or experiment to find a better one.

Laps For Cutting The Soft Gem Materials

In many cases the soft gem materials can be cut on one of the usual diamond laps. Under these conditions the lap must be as true as possible. A bumpy lap will remove chips. Here the commercial charged lap is almost indispensible. These laps are exceedingly flat and true, with a minimum of projecting particles of boart.

Gem materials that are too sensitive to be cut with a diamond lap will need a lap that offers as little shock as possible. One combination well suited for this is micarta plastic with very fine (1200 grit) carborundum. Micarta is the

familiar plastic sheet used for covering sink and table tops. The extremely smooth surface virtually eliminates shock to a stone. This lap can be made by carefully cementing a disc of the plastic to a metal backing.

The carborundum in a water mix is applied to a turning micarta lap in much the same manner as diamond powder for polishing. A certain amount of the grit will partially embed in the micarta surface, but it will not stay in place for a long period. It is necessary to replenish the supply of grit at intervals, but an excess will not be an advantage. Any excess is quickly slung from the lap and only contributes to a messy situation, and possible contamination of surrounding equipment. Technique is very important and fairly frequent applications of small amounts of grit will be found best.

It is sometimes difficult to purchase 1200 carborundum grit. Slightly larger grits could be used, but these will begin to defeat the purpose of the combination. A well graded levigated alumina or tripoli could be used as a replacement, but these are usually not of uniform size. Diamond powder of 1200 grit or 1800 grit would be very satisfactory, but this is costly material, and the method is wasteful.

For some of the very soft materials, a wax lap is recommended for facet cutting. This is the same lap used for polishing some soft materials, and is described in a later section. The wax lap under cutting conditions is used much as in polishing, with a cutting agent such as tripoli or Linde A. The use of Linde A as a cutting agent is, in reality, a simultaneous cutting and polishing operation.

Later in this chapter the reduction of speed during the polishing of soft materials is discussed. This speed reduction is important to protect the brittle or easily cleavable materials. If this is true for polishing, it could also hold for cutting. When a gem will polish easier and better with slow speed, it would be wise to use a similar speed for cutting.

Laps To Polish Soft Gems

A few soft gems will polish on laps used for ordinary gem minerals, but the best laps for most soft gems are made of soft materials. The most popular of these soft laps is one made of wax. Others are made of felt, wood, pitch, and vinyl.

Felt laps are little used as they tend to excessively round facet corners. The lap is easily procured as a felt buffing wheel, with the side being used. Wood laps are turned from a fine grain tough wood. The face of the lap is on end grain. Wood laps also tend to excessively round facet junctions. A pitch lap is made of 50% rosin and 50% ordinary roofers tar. It is made in the same manner as the wax lap described below. The authors have had small success with felt, wood, and pitch laps, but others have reported good success. It is recommended that they be tried when all else fails.

Some of the softer plastics in sheet form will polish some of the soft gems. Vinyl is the commonest, and is easily obtainable. Vinyl sheet flooring, glued to a suitable backing, has been used. Some brands of flooring contain sand or other abrasive to enhance the wearing qualities. This type is obviously not suitable for faceting. A second source of vinyl, and one that is always pure,

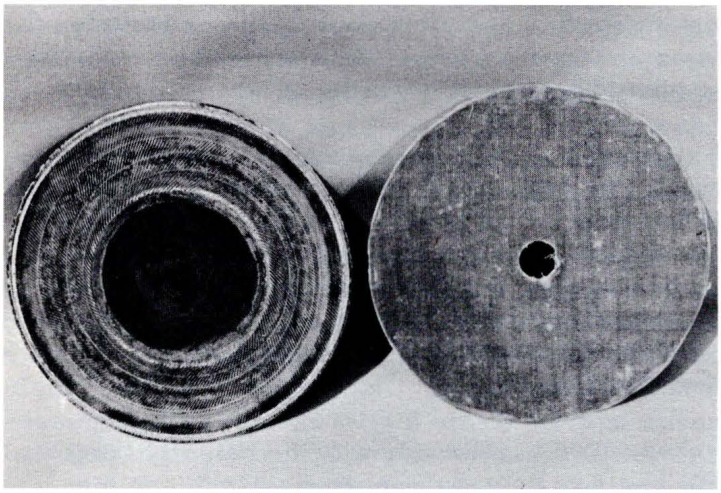


Figure 110.
Polishing Laps for Use with Difficult Gem Materials.

is the modern long-play phonograph record. In Figure 110 a phonograph record (left) is shown with a wax lap.

An eight inch diameter lap cut from a record is excellent. The large label on most records reduces the working surface on a six inch lap to about 1 1/2 inches in width, but with care this can be ample. The label in most cases is very difficult to remove. Vinyl laps must be scored for use in the same manner as metal laps. The original grooves of the record will tend to leave polish marks on the gem unless it is moved rapidly across the lap surface during polishing.

Making A Wax Lap

The most useful lap for polishing soft gems is made of beeswax. In the pure state, this wax is soft, but the addition of 10% to 15% of carnauba wax makes a harder and tougher lap.

The simplest wax lap is made with a coating of wax on some suitable metal backing. Wood backings have been used, but they tend to warp if they become wet. Wax will ordinarily adhere readily to metal, but some sort of cushioning or suspending agent is placed between the backing and the working surface. Ordinary pillow ticking, or some other tight weave cloth, is excellent.

The metal backing may be as thick as the faceter desires, and almost any type of metal will do. The thickness should not be less than about 1/32 inch. The metal backing is slowly heated until it can easily be coated with melted wax. The heating is best done over an electric hot plate. An open flame is a potential fire hazard. The wax is placed on the hot metal disc either as chips or by wiping on a chunk. The latter is preferred by the authors. When a layer of melted wax about 1/32 inch thickness is on the backing, a previously cut disc of the cloth is applied while the metal is still being heated. The cloth must be carefully slid into place, and all air bubbles forced out to the edges. More wax is now carefully applied to the cloth surface until it is completely covered with a thin layer of wax. The lap may now be removed from the heat and placed on a perfectly level surface. More wax is applied by wiping a chunk over it, as shown in Figure 111. This is continued until the lap has cooled to the point where it will take no more wax. At this point there should be at least 1/16 inch of wax above the cloth. The surface will not be smooth, but it should not be lumpy.

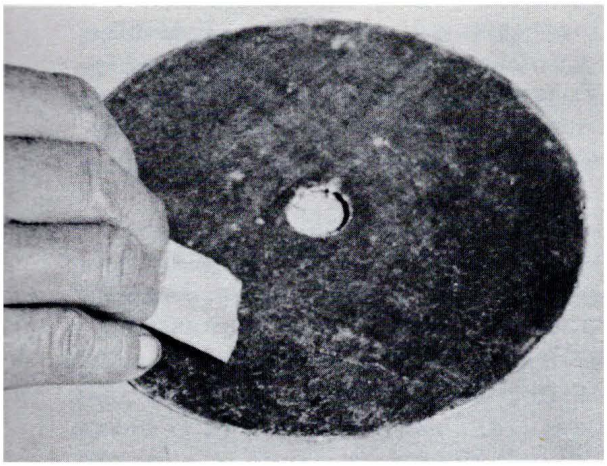


Figure 111. Making a Wax Lap.

A much more satisfactory wax lap is made as shown in Figure 112. Here the wax (D) is poured into a recessed disc. The disc, made from some thick material, is turned on a lathe. A soft metal, such as aluminum, is excellent; and a "lucite" disc, such as a discarded polishing lap, is quite suitable. The recess should be at least 1/8 inch deep, and extend from about 1/8 inch from the edge (A) to close to the center (B). The arbor hole is shown at C. The bottom of the recess need not be smooth; a rough surface makes a better bond with the wax.

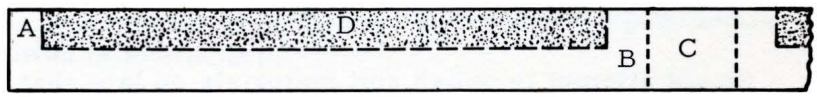


Figure 112.
Recessed Disc Type of Wax Lap.

The prepared disc is warmed to a temperature about that of the melting point of the wax, but not above. Melted wax is now carefully poured into the recess, until it is completely filled, and its surface is slightly above the original disc surface. Be careful that bubbles are not trapped in the wax layer. The whole unit should now be cooled. Cooling will cause the wax to shrink slightly, to where most of its surface will be at about the level of the disc surface.

Truing Wax Laps

The best method of truing either type of wax lap is to scrape the surface with the lap turning on the faceting machine. The truing is done by some straight-edged tool. A razor blade used as in Figure 25, page 46, will do nicely, but it will do only part of the radius and may not create a flat surface throughout. A large putty knife or a section from a metal ruler is a good choice. The job goes much smoother if the surface of the lap is kept wet during the scraping process. If the wax surface is true, little scraping is needed. Scraping of the cloth type should be carried out only until the surface is smooth, and not until the cloth layer is exposed. If the cloth is quickly exposed, not enough wax was placed upon it. If the cloth exposes in some areas while others are well covered with wax, the heat was too low, and the wax went on in lumps. If this is the case, redo the job by heating and applying more wax.

Shock is a problem with soft gems, and the lap should be as smooth as possible. Truing the lap on a lathe will give it a perfect surface. A wax lap wears away rapidly, and must be trued frequently. This will usually necessitate having more than one lap on hand. The wax lap is expendable, and if the faceter does many of the soft gems, he will have to resort to frequent manufacture. The poured type of wax lap has a much greater expectant life over that of the disc and cloth type, and would be the better choice for the faceter doing numbers

of soft gems. There is no need for scoring the surface of a wax lap. Polishing agent is easily embedded in the surface under ordinary conditions, and there is little possibility of aggregation and flow. Wax laps have one drawback that cannot be overcome. A small amount of facet rounding is always evident, with the softest materials showing it most. If no other lap will polish a gem, rounded facet edges will have to be accepted.

Some of the very soft materials of high density have a tendency to flow excessively while being polished. Often a small lump of the gem material will appear at the following edge of the facet. This is sometimes very difficult to control, but the best method is to sweep the stone rapidly to and fro across the lap. This automatically assumes that the wax surface is very flat and true.

Polishing Agents For Soft Gems

The most usual polishing agent used with the soft gem materials is Linde A. If others are needed, they may be noted in the species descriptions. It is very seldom that a soft gem will not respond to Linde A. Regardless of the agent used, the techniques of using it will be the same.

Do not attempt to polish soft materials on laps that have been previously used for stones above 6 in hardness. It is very possible that small chips of the hard materials may be embedded in the lap surface, and these will invariably scratch.

To carry this situation to a logical conclusion, it could be a wise practice to have separate laps for each of the three groups. It is very possible for a chip of a Group One mineral to scratch one of Group Two, etc.

THE TECHNIQUE OF POLISHING SOFT GEMS

The polishing of most minerals in Groups Two and Three is done on special laps, and information as to which lap is most suitable is given in the species descriptions. Even with these special laps, polishing requires meticulous care. Polishing pressure is usually a small fraction of that used for the harder gems. The faceter must acquire a "feel" of a light touch in order to polish soft materials. In most cases, the pressure need not be more than the weight of the quill. If the quill is heavy and exerts more than a few grams of pressure on its own, it may be necessary to learn to hold it in such a manner that only part of its weight is exerted on the stone.

Wax and plastic surfaces show a decided lack of affinity for water. No matter how clean the surfaces may be, they retard the spread of water over the surface just as if they were coated with a layer of grease. The polishing agent is best applied to these laps in a fairly thick slurry. The added weight of the excess polishing agent forces the water to spread over a larger area. The use of some wetting agent, such as a household detergent, will assist in the spreading, but even this is not entirely successful. These laps are very soft, however, and the polishing agent is quickly caught in the surface, with a slight embedding. When a reasonable number of particles are embedded, the water in the slurry will creep across the lap surface from particle to particle, and after a short period of time wet the surface.

One excellent technique on the soft laps, especially the wax lap, is to finish the polishing of each facet as the lap dries. The materials of great heat sensitivity

will not tolerate a dry lap, but will nevertheless take a better final polish at a point close to dryness. It must be emphasized that the period of dryness should seldom exceed more than a few seconds. Polishing dry, or nearly so, on any gem material is a very precarious process, and should be done with great care.

LAP SPEED IN POLISHING SOFT GEMS

With the recent increase of interest in the softer gemstones, new ideas and techniques have evolved. The most important of these is the varying of lap speed, especially in the polishing process.

Even though information on many gem materials is unavailable, it is evident that many soft materials will polish appreciably easier and better if the lap speed is greatly reduced. This method was first reported by Mr. E. C. Parrott, of Spokane, Washington.* He found that sphalerite would take an excellent polish on a tin lap with Linde A as a polishing agent, at about 10 revolutions per minute. This is a very slow speed, and greatly different from the usual speed of about 400 rpm. A lap speed of about 10 rpm is not much different from simply wiping the gem across a motionless lap. For materials requiring a speed this slow, the wiping will work. It is tedious, but is worth trying if no other method of speed reduction is available.

The motors usually used to drive faceting machines are of the induction type, and their speed cannot be varied more than a small amount. Belt driven speed reducers will lower most lap speeds to about 100 rpm, but these units are very bulky.

The first unit used by the authors to reduce lap speed was a separate motor with a built in worm gear speed reducer. It worked nicely, producing a speed of about 30 rpm, but could not be varied. Much information was gained from the use of this unit. It was soon apparent that only a few soft materials would easily polish at this speed, and that higher speeds between 50 and 100 rpm were needed. After some searching, and a number of trials, a few satisfactory units were found.

Variable Speed Units

The easiest unit to obtain is an ordinary electric mixer of the type used in the kitchen. The only modification needed is to fit a small pulley to one of the beaters on the lower side of the mixer, or to the juicer on the upper side. Which one is used will depend upon how the individual facet head is constructed. The small pulley is belted onto the regular pulley on the arbor. The direction of turn of the lap is of no consequence. The usual good electric mixer has a wide range of speed variations from very slow to faster than needed. This offers an excellent speed situation, but is excessively noisy. The constant whine of the gears, etc., may be hard on the nerves.

The best answer to the speed reduction problem, at least at present, is with the use of some type of series motor; the type with internal brushes. The speed reduction is accomplished with the use of one of the electronic speed reducers. One of these units is pictured in Figure 113 on the next page. With small shop tools, such as electric drills, etc., for which they were developed, it is

* See - Lapidary Journal; May 1963, page 291.

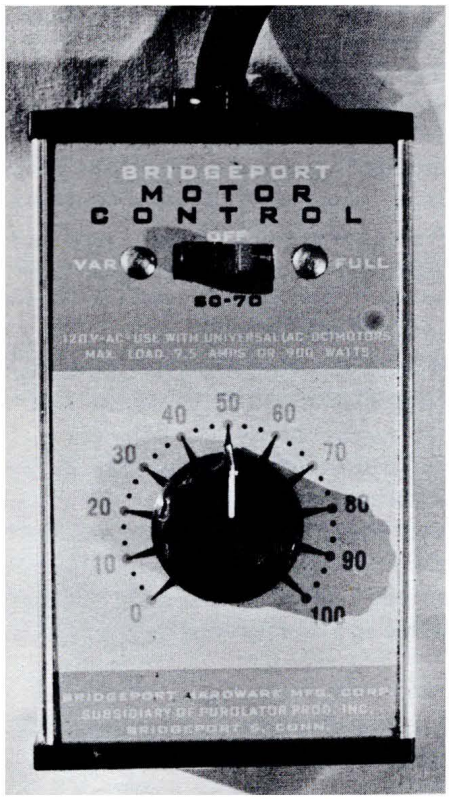


Figure 113. An Electronic Speed Control.

possible to dial any speed from near normal down to 25 rpm or even less. The slow speed is singular in that the unit delivers about the same torque as at the normal high speed.

Electric drills may be used as slow speed units. These drills are easily obtained, and reasonably priced. When coupled with the speed reducer they will work well. All that is needed is to place a small pulley, fitted with a small shaft, into the chuck of the drill. It may be mounted into a rigid position with clamps, etc. This type of unit also has a noise problem, but it is better than the electric mixer.

The most satisfactory motor known to the authors is the series motor used for small appliances. Some are rated at 1/10th horsepower, which is ample. These are used with the electronic speed reducer. The motors are easy to mount on the faceting unit. Some of them are fitted with a mounting base. Other makes are without a mounting base, but are tapped for small bolts. These motors have a normal speed of about 5,000 to 10,000 rpm, which is far above that ever needed by the faceter. The speed reducer will slow this to about 25 rpm. This type motor is also noisy, but less than the other two units discussed. The control with this combination is excellent, and it can be used to produce almost any speed needed.

These units have an inherent idiosyncrasy that must be treated carefully. At low speeds the fan within the motor does not correctly ventilate and there is a tendency to overheat. Stopping the motor whenever it is not needed, or turning it up to full speed for short periods will help to overcome the problem.

USING POLISHING LAPS AT SLOW SPEEDS

Polishing of the soft gemstones may be done on ordinary polishing laps with very slow speeds. One aspect of slow speed must be recognized and coped with. Lap speeds of below 100 rpm do not generate much centrifugal force. Polishing agent, water, and other materials are not thrown off. The fact that polishing agent is not thrown off is a boon to the faceter. On the other hand bits of any type of contamination, such as grits that may fall from clothing or hands, will also stay on the lap, and will scratch if they pass under a facet. It is important that a fresh and clean supply of polishing agent is used. Be certain that all equipment is scrupulously clean and that it stays that way during this operation. This is not a bad practice at any time.

TABLE 16

POLISHING LAPS USED WITH REDUCED SPEEDS.

Mineral	Group	Lap	Rpm	Mineral	Group	Lap	Rpm
Actinolite	one	tin/lead	100	Kyanite	one	tin/lead	100
Amber	three	wax	100	Legrandite	---	tin/lead	100
Analcime	---	"lucite"	100	Leucite	---	tin/lead	100
Anglesite	three	wax	50	Ludlamite	one	wax	50
Anhydrite	three	wax	50	Magnesite*	one	tin/lead	50
Amblygonite	---	tin/lead	100	Natrolite	one	"lucite"	100
Apatite*	two	tin/lead	100	Obsidian	one	"lucite"	100
Apophyllite	two	tin/lead	50	Opal	one	tin/lead	100
Aragonite*	two	tin/lead	50	Petalite	---	tin/lead	100
Augelite	---	tin/lead	100	Phosgenite	three	wax	50
Axinite	---	tin/lead	100	Phosphophyllite	---	wax	35
Azurite*	two	tin/lead	50	Pollucite	---	tin/lead	100
Barite	three	wax	50	Prehnite	---	tin/lead	100
Beryllonite	one	tin/lead	100	Proustite	three	wax	35
Brazilianite	one	tin/lead	100	Pyroxmangite	---	tin/lead	100
Calcite*	three	wax	35	Rhodochrosite*	two	tin/lead	50
Cassiterite	----	tin	100	Rhodonite	one	tin/lead	50
Celestite	three	wax	50	Scapolite	---	tin/lead	100
Cerussite	three	wax	50	Scheelite*	two	tin/lead	100
Cinnabar	three	wax	35	Serpentine	---	wax	50
Colemanite*	three	tin/lead	50	Siderite*	two	tin/lead	50
Crocoite	three	wax	35	Smithsonite*	one	tin/lead	100
Cuprite	two	tin/lead	50	Sphalerite*	two	tin/lead	35
Datolite	one	"lucite"	100	Sphene	---	tin/lead	100
Diopside	---	tin/lead	100	Stibiotantalite	two	tin/lead	50
Dioptase	one	tin/lead	100	Sulfur	three	wax	35
Dolomite*	two	tin/lead	50	Tremolite	one	wax	100
Enstatite	---	tin/lead	100	Vivianite	three	wax	35
Feldspar	---	tin/lead	100	Willemite	one	"lucite"	100
Fluorite*	two	tin/lead	100	Witherite*	two	tin/lead	100
Hodgkinsonite	---	tin/lead	100	Wulfenite	three	wax	35
Idocrase	---	tin/lead	100	Zincite	two	tin/lead	100
Kurnakovite*	three	tin/lead	35				

This table includes the minerals of the three soft groups (tables 13, 14, 15), plus others that have been found to polish with greater ease with slow speed. It is becoming obvious that speeds slower than normal (approx. 400 to 600 rpm) are advantageous in polishing almost any gem below 7 in hardness.

An asterisk (*) indicates a change of both lap and speed (from the species descriptions); no asterisk indicates only a speed change.

The members of group two, with only a few exceptions, will polish on a metal lap at a reduced speed. Few of group three can be done on anything but a wax lap, but polishing is much easier at reduced speed. Group one normally will polish on a metal or "lucite" lap, but the slower speed enhances the polish without any change of lap.

Revised Table For Slow Speeds

Groups One, Two, and Three, offered earlier in this chapter, were compiled with the ordinary faceting machine in mind. The use of the soft plastic and wax laps is all that is needed to attempt polishing of the soft gems. These charts do not take into account the use of the reduced speed technique discussed above. Table 16 is presented for those who wish to avail themselves of speed reducing equipment. This table lists the lap and approximate polishing speed for the gem materials that have been found to respond to this technique. Any omissions of minerals listed in the three former charts are absent either as a result of lack of information, or failure to note any difference between the two methods of polishing.

Advantages Of Slow Speed Polishing

There are a number of decided advantages of slow speed polishing. The foremost of these is the elimination of shock. A certain amount of shock to the gemstone is inherent with normal cutting and polishing speeds. Another decided advantage is the reduction of aggregation and flow. This phenomenon takes place most commonly at high speeds, but with slow speeds there is not enough energy present to force lumps of polishing agent under the facet. At the same time, slow speeds do not create the vacuum that assists in the process. With the reduction of the potential for aggregation and flow, which is really what causes scratches on soft materials, the polishing process can and usually will proceed without mishap. Polishing may be slow, but this should be of little consequence.

It will be noticed from Table 16 that many of the gems will polish on the metal laps rather than others recommended earlier. With this combination it is now possible to produce a polish on many of the soft gems without any rounding of facet edges. The surface of the metal laps used here should not be scored. A smooth surface offers no appreciable resilience which produces the facet rounding. If wax laps are necessary for some gems, the slower speeds tend toward less rounding.

It must be understood that the producing of gems from the soft materials is still in its infancy. The use of slow speeds is still largely experimental, and the information available is far from complete. Time and more research into this very interesting branch of faceting will undoubtedly give us a more refined technique.

Chapter XIII

Disposition & Care of Gems

AFTER A FACETED gem is completed, something must be done with it. A gem should not be tossed into a box with odd items and be forgotten. It represents an investment in both money and time; is a relatively fragile thing, and must have reasonable care.

HANDLING AND CLEANING

Gems should be handled carefully. A fine aid in handling of the usual shaped gems is the diamond tongs as shown in Figure 114. This easy to use instrument is excellent for showing gems to small groups of persons, as well as in handling during sorting or the planning of exhibits. Chipping and scratching can be virtually eliminated, and dropping of the gem is greatly reduced. The greatest value of diamond tongs is being able to handle a gem without covering it with fingerprints.

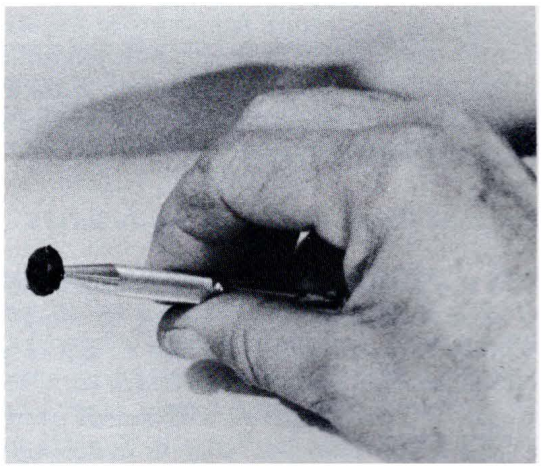


Figure 114. Using Diamond Tongs.

If a faceted gem is to show its optical properties to the best of its ability, it must be clean. Dust or smudges on the

table and other crown facets will greatly inhibit the entry of light rays. Any type of material adhering to the pavilion surfaces will hamper the reflective ability of the gem.

The cleaning of a faceted gem is simple, but must be done with care. Soap and soft water (distilled water is highly recommended) followed by a thorough rinsing will do a good job. Household detergents are better as less care is needed with the rinse. Presently on the market are some gem and jewelry cleaners that need little more than dipping and rinsing with soft water. Scrubbing the gem with any type of cloth or tissue always carries with it the possibility of scratching a facet surface. The household detergents and prepared cleaners rinse off easily, leaving a surface that will dry without any water spots.

After a faceter has finished his gem and understands its care, he must decide what he will do with it. This decision is not a problem, and there are at least four avenues open to him.

SALES OF FACETED GEMS

Regardless of the fact that this book is intended primarily for the guidance of amateurs, many will on occasion dispose of gems by sale. It should be obvious that if the directions and sequences herein are followed, the time spent in cutting a gem can seldom be compensated for in a sale. It is true that from time to time certain customers will be found who will pay any reasonable price for an exquisitely cut unusual gem.

The usual gems in the usual cuts are presently produced in prodigious numbers by foreign labor so reasonably priced that the American faceter cannot possibly compete, no matter how the two types of gems may compare.

The occasional sale of a fine gem by an amateur should be perfectly permissible, as long as he does not violate any laws doing so. Even though there is a certain amount of remuneration involved, this can be an excellent method of sharing one's hobby with others.

Prices For Faceted Gems

Arriving at prices for custom faceted gems may be a problem. As stated above, such gems are not comparable to foreign cut gems, and the price of the latter is very low. In order to figure prices of custom gems, the faceter will have to work out his own price schedule. He may revise this from time to time when the need arises.

Original Price Of Rough As A Basis

On the contingency that at sometime a gem may be sold, it would be reasonable to keep a record of the price of rough that is purchased. Such records are advisable in any event. If the rough is purchased in lots by weight, the price per unit of weight should be recorded. Most stones yield about 20% of the original weight. The weight of a finished gem need only be multiplied by five, and then by the price paid per unit in order to determine the approximate cost of the individual piece of rough. To arrive at a final price this total is added to the figure for the cutting costs.

Cutting Costs

If one is desirous of recovering a fair amount for his labor, he must work out some method of arriving at a figure to cover it. It would be difficult to keep an accounting of all time spent on all gems on the contingency that some of them might be sold. Even if most gems are to be sold, this accounting would be a nuisance. The answer lies in working out a schedule based upon a certain price per unit of weight of finished gem.

Many faceters who do custom cutting have worked out a schedule based upon the following operations. There is a certain amount of time necessarily spent before faceting begins. This includes orienting the rough, preforming, and dopping. A figure should be set to cover an average amount of time for this job. This should be reduced to an amount based upon a wage per hour. Seldom should the pre-faceting tasks take more than an hour once the faceter has attained an efficient technique. Indeed, the faceter should not be trying to do custom faceting before he has developed an efficient technique.

The price to be charged for the actual cutting and polishing process will vary according to the size of the gem. The time necessary to cut a gem of ten carats is less than ten times that necessary to cut a like gem of one carat. Some faceters have found that pricing the cutting according to a monetary unit per carat is quite satisfactory. If the first carat of a gem would equal one unit, then any subsequent carats would be priced slightly less, on a descending scale. If the gem is perfectly flawless, it is reasonable to add something to the price, and conversely, subtract a small amount if the gem is flawed.

TRADING OF GEMS

On occasions, the faceter will find an individual with a small amount of fine rough gem material who will take cut gems for some of the rough. Some of these persons may be willing to part with some of the rough if part of it comes back in the form of cut gems. Either case is trading; the first, a trade of gems for rough; the second, a trade of services for rough. A good basis for either trade would be the monetary schedule as outlined above. All that would be necessary is to arrive at a price for the other person's rough. Many faceters build a supply of rough by this method.

It might be possible to trade well cut gems for the rarer materials in the form of foreign cut gems. These gems are discussed in Chapter V. Foreign cut gems may be obtained from individuals in the jewelry trade, and they might be willing to trade them for nice gems that can be used in their business.

Faceted Gems As Gifts

Faceters will find many opportunities to use their handiwork as gifts. They could be mounted in jewelry, as discussed below, or given away as they are, to be enjoyed by the recipient as a thing of beauty or a keepsake. There are many faceters that refuse to sell their gems in order to not fall into a professional class. They may on the other hand freely give a gem to a friend or relative. No matter what the motive, making gifts of one's work is a very personal thing that carries with it more than the gift.

JEWELRY MADE WITH FACETED GEMS

A very obvious method of making use of faceted gems is in the making of jewelry. Some faceters may have been previous jewelry makers, or may take up the art because of having the gems on hand. In many cases, one individual is the faceter, and the spouse creates jewelry with the gems. There are many excellent books available to help the amateur perfect such a craft. Pieces of handwrought jewelry are shown in Figure 65, page 96, and on the right in Figure 115.

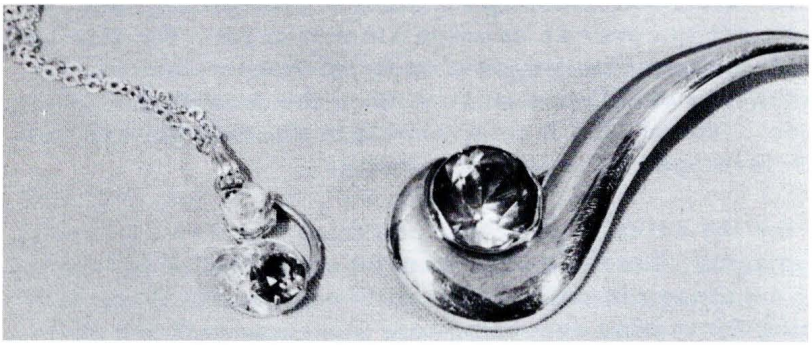


Figure 115.
Faceted Gems in Jewelry.

Using Commercial Mountings

There are many mountings on the market that will accept faceted gems. These may be obtained in sterling silver, or a number of karat percentages of gold. Most of these are of good workmanship and of tasteful design. One is pictured on the left in Figure 115. It is the product of M-Line By Hilda, Tucson, Arizona.

Commercial mountings have one drawback in that they are designed to take only a few sizes of gems. The mountings that will accept oval or rectangular gems cover only a few sizes and proportions. Those that will accept round gems have a better size range, and many may be adjusted to fit gems slightly larger or smaller than the given range. This does not give the faceter much latitude for the matching of gems cut to yield the greatest amount from the rough. If the faceter wishes to make a certain gem into jewelry using a commercial mounting, it is best to first procure the mounting, and then cut the gem to fit. This is not a difficult task, but it can be wasteful of rough material.

In recent years a number of manufacturers have started to market mountings that are adjustable to fit odd shaped gems, or various sizes of the usual shapes. Many of these are good, and the adjustments are within the limits as specified by the manufacturer. Many commercial settings are designed for shallow gems (in some cases only fish-eyes will fit), but as demand for more adaptable types of mountings becomes greater, better ones will gradually appear. Most manufacturers will find it a simple matter to alter their product to accept the deeper gems done by the amateur.

A COLLECTION OF FACETED GEMS

Regardless of why an individual may begin faceting, or how he intends to make

use of his gems, he will soon find he has a collection. The most common reason that starts a faceter on his way is a desire to build a collection, and as a result it is in order that some space be devoted here to the building of one. A good collection of gems is the most satisfying and ultimate goal of the faceting process. The degree of enjoyment from a collection of gems depends greatly on how well the gems are sorted, catalogued, and displayed.

Care Of A Collection

A faceter must first decide upon a place of storage for his gem collection. Each stone must be placed so that it cannot touch another, otherwise chipping will result. Each gem must be individually held in such a manner that it cannot easily move with ordinary handling of the container. The container must be of sufficient strength that the gems are protected from damage by crushing.

Containers To Hold Gems

If one is to have a collection of only fairly large gems, and only a few of any one species, small boxes that hold a single gem are excellent. Presently, on the market are hinged clear plastic boxes of a wide variety of sizes that may easily be adapted to this use. Figure 116 shows two of these boxes fitted with a hard foam liner, each displaying a gem. Some portion of the box may be marked with the name of the gem, and any other data desired. Here is a maximum of protection, with a minimum of care. Storage is simplified by the placement of a piece of soft foam within the lid to stop movement of the gem. Do not use cotton or other lint producing material. To display the gem, it is only necessary to open the box, fold back the lid, remove the foam padding and the gem is ready to view.

Figure 116. Gems Displayed Singly.

A large collection containing stones of various sizes might create a storage problem if individual boxes were used. If one wishes to collect the color varieties of beryl, quartz, or tourmaline, this method of storage would not adequately show these features. Here the most satisfactory method of storage might be the grouping of a single species or a few species within a single container. A suite of tourmalines within a single container is a breathtaking sight, and much enjoyment may be had by the viewer as well as the collector under such circumstances.

When gems are stored in groups, some method of separation must be worked out. Depressions in foam to fit the individual gems will do very nicely. Divided boxes, such as "thumbnail mineral" boxes will give each gem a compartment of its own. A foam pad placed over the group will keep them from moving during transportation. The above two methods need special care when handling to

insure that the box is not tipped. Gems spilled under these circumstances can easily be damaged. Worst of all, identification of the individual gems may be badly disrupted if not lost as a result of spillage.

If gems are to be stored or displayed in groups, some method of holding the individual gem must be used. Gluing the gem into a mount is completely unsatisfactory as any glue on the pavilion completely destroys the reflective properties. The gem must be held in such a manner that air is in contact with as much of the pavilion as possible.

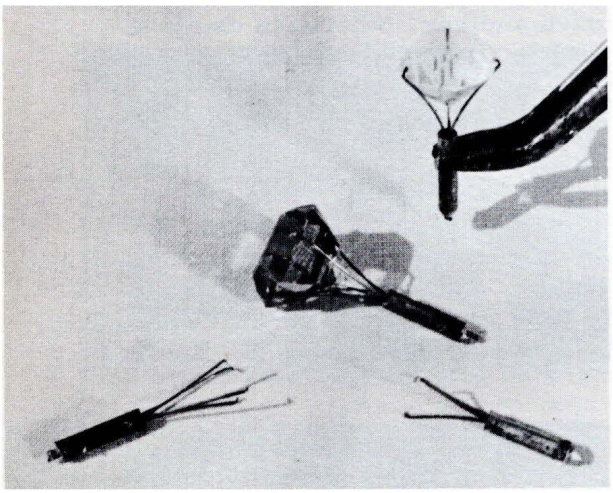


Figure 117. Mounting Prongs for Displaying Gems.

The safest and most satisfactory method of holding gems is by use of small prong holders as shown in Figure 117. These may be made of spring wire soldered into small diameter copper tubing, and tailored to fit each gem. This type of mount offers a maximum of security and ease of handling. Excellent viewing angles may be obtained by placing the stems at the correct inclination into any suitable backing. The complete unit may easily be handled with tongs as shown. Fingerprints and accidental dropping are virtually eliminated. These holders may be slipped into holes drilled in the bottom of storage boxes, or holes punched into foam.

Cataloguing A Collection

Whenever more than a few gems are on hand, some method of being certain of the identity of each must be employed. It is impossible to attach a label to a gem, at least in the direct sense.

The method of storing gems singly in individual plastic boxes as discussed previously lends itself nicely to cataloguing on an individual basis. This is based upon the assumption that the gem will not be removed from the container and the data attached to it. The use of the thumbnail mineral box will work the same as the individual box. The information for each gem may be placed in a corresponding position on the inside of the lid of the box.

The safest method will be to have a card catalogue for any sizeable collection. There may be a card for each individual gem, or a card for each species, again depending upon the size of the collection. On this card may be placed the physical identification of the gem.

Physical Characteristics Of A Gem

The identity of any gem would be quickly and easily possible if the list for each gem included the following: the type of cut, the number of facets, the weight, the millimeter measurements, the color or colors, and any noticeable inclusions or surface imperfections. Most of this information can be found on the work sheet described in Chapter X. When the cutting job is completed, this information plus any other desired, can be transferred to the file card. If desired,

the work sheets may become permanent records, with the other information added to them. No matter how these records are kept, these physical characteristics become a "fingerprint" for the gem. They would be invaluable in the case of theft. Spillage is always a possibility regardless of how the gem was stored or handled. Without this data, there might be a need to have instruments such as a refractometer for identification. One can easily imagine the resulting chaos if an uncatalogued tray of gems was dropped accidentally. With a catalogue card for each gem, the restoration of order would be fairly easy.

Cataloguing Prong-mounted Gems

Any gems in a collection that remain free and unmounted cannot be feasibly marked for identification. If the gems are held in some kind of holder such as in Figure 117, it is possible to mark the stem of the holder with some kind of code. Gems catalogued and marked in this manner are always identifiable as long as they remain in the holder. If one or two gems in a group are accidentally removed from their holder, correct replacement is a simple matter. All that is necessary is to assign some set of numbers, or letters and numbers, to each gem species. Each gem can then carry a distinctive code number within the band assigned. This is the method used by the authors.

Types Of Collections

A collection of gems in general, with little or no specialization, is commonly done. Nearly all faceters find themselves with this type of a group of gems on hand whether it was planned that way or not. Such a collection may reach prodigious proportions, and unless the collector is financially able, he cannot hope to obtain a specimen of every gem. He will be hard pressed to collect three-fourths of the known gems. Certainly such a collection is a justifiable aim, and not to be criticized whatever percentage is obtained. It does seem more reasonable, under the circumstances, to specialize in some way to insure that a smaller group of gems might have the potentiality of appearing complete as a collection.

Large Gems

A collection of gems of about ten carats or larger can be excellent. It may appear to be complete to the viewer when only a relatively few gems are on hand. It could never really be complete until all gems are represented, but if large stones are the aim, the number is unimportant. This type of collection can be very showy and even breathtaking. The gems could be housed very nicely in the hinged plastic boxes illustrated in Figure 116. As this type of collection in all probability will never reach great numbers, storage will not be a problem. The cataloguing of such a group of gems has been discussed above. Under these circumstances each gem could hardly have a near counterpart, and keeping them identified would be a small matter.

Cut Gems And Rough To Match

A variation of the general collection is one of gems and a fine piece of rough to match. The average individual is often very surprised to find that gems are cut from seemingly dull and quite shapeless pieces of rough. These "shapeless pieces", as all faceters know, are not easy to obtain, and a collection that calls for two (one cut into a gem) is not an easy thing to accomplish. Even though the

feeling of never being complete is present with this type of collection, the fact that each unit is double gives a look of completeness to a fairly small collection.

If the collector wishes to go all the way with this type of thing, he can create a cut and rough collection with the rough being gem crystals. This is a superlative type of collection, and can become quite valuable. Gem crystals bring much higher prices than an equivalent in a piece of ordinary rough. They are much sought after by gem and mineral collectors. In reality this is two collections, with the obtaining of the gem crystal portion calling for as much effort as obtaining the gem rough. There can be more investment in the crystal than there is in the gem.

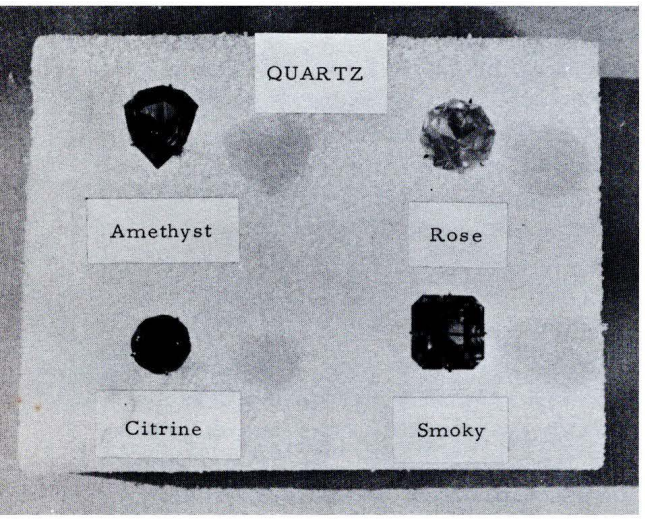


Figure 118. A Suite of Quartz Gems.

Suites Of Colors

A very popular collection is one that contains the various colors of a mineral species. The color varieties of tourmaline are almost endless. Quartz and beryl have many colors and shades, as do topaz, garnet, zircon, and opal. Obtaining the greatest possible number of colors of any of these species is a real challenge. Even though the color varieties of tourmaline can be considered to be nearly a hundred, a collection of only a half dozen is a handsome thing. At this point the collector has an intriguing collection to show while he is diligently searching for other colors. Figure 118 shows a suite of quartz gems.

Some gems appear in only two or three colors, but these are so startling or interesting that they can easily grace a general color suite collection. The possibilities of this type of collection are such that one may easily be satisfied with a suite of only one species, or the collector may stop at any reasonable point beyond. Market availability or his finances could be the factors that will determine how far he might go.

A Variety Of Cuts

The faceter that wishes to be versatile may make a collection of as great a number of different cuts as possible. This may be carried out in a single gem species, something that the faceter can collect himself, or it may be done as part of a general gem collection. Again, the completeness or variety is entirely up to him.

During the past few years it has been popular to reproduce the famous diamonds of the world.* These may be cut from clear quartz or topaz. Other possibilities in cuts could be chosen if the faceter wishes to do something different. A well advanced faceter might develop variations on the more standard cuts, or even devise new cuts.

* See - Lapidary Journal; various issues 1960 through 1963.

The Rare Or Unusual Gems

The terms rare and unusual, when applied to gems, are not synonymous. It is true that a rare gem is in a sense unusual, but the unusual gem materials are by no means to be considered always rare. As an example, emerald is not an unusual gem, but in good quality is rare. Calcite in gem quality is not rare, but seeing a gem that has been cut from this material is an unusual sight.

The truly rare gems are those that are of sufficient hardness to be worn in some type of jewelry, but are difficult to obtain. Among these we can list ruby, emerald, benitoite, kornerupine, demantoid garnet, and others. To obtain some of these gems as rough, as in the case of kornerupine, is a virtual impossibility. Recutting native cut stones is the only practical way to get some of them. Others of this group are difficult to find in any form. A collection of rare gems can be very valuable, and if the individual stones are of an appreciable size, it can be very showy. The rare gems could be a drawback for the collector in that what is rare today may not be so next year. There was a time when danburite, a fine clear gem, was considered very rare. Cutting material was available from a very few localities, and the quality was seldom good. Danburite was discovered in Mexico, and the mine produced such large amounts of excellent material that it quickly dropped off of the rare list. An almost parallel situation existed for sphene.

The Unusual Gems

A host of minerals appear in gem quality, but because of a poor characteristic or group of characteristics, they are seldom cut commercially. The cutting and polishing of members of this group is covered in Chapter XII.

The faceter that wishes to exhibit a fine technique, as well as some beautiful gems, will find this group made to order for him. He will work for hours just to polish one facet on some of these; or he may search for years for such a piece. Nevertheless, when he has finished his gem, he will have done something that few others have done. There is no question that a collection of the unusual gems will attract more attention than any other.

The above list of collection possibilities is certainly not imposing, or is it complete. Other collection types, such as gems from one location, may occur to the faceter. Each type of collection discussed offers to the faceter a satisfying method of using his gems, and at the same time makes a fine medium to offer enjoyment to others. It is hoped that the list of collection types will have at least one that will appeal to each faceter.

Basic Reasons For A Collection

A collection should give satisfaction to a collector in one of the following areas. The primary aim for the collector to consider is that of accomplishment. This feeling can be very real with the cutting of only one gem, but is greatly increased with numbers. If the collection is a hodge-podge, hidden in boxes or bags, there is no proof of accomplishment.

A collection of gems is valuable. In general, when a piece of rough is cut into a gem, the price per carat increases about tenfold. If a rough tourmaline of good quality is worth $1.00 per carat, the finished gem should be worth at least

$10.00 per carat. This escalation is not as great as it may appear. As was noted earlier in a previous chapter, there is at least a 75% cutting loss, but simple arithmetic will show that the monetary gain is considerable. A faceter can feel that he at least in a sense is earning money, and if good gem materials are cut, he can be well on the way to creating a valuable estate.

Anything as valuable as a collection of gems needs the consideration of some insurance. A number of kinds of insurance are available to the collector, and some may be altered to fit his needs. In some cases the faceter may wish to insure each gem and state its value. Other policies will set a maximum amount of insurance, with no single gem being worth over a certain amount. The first type of policy calls for a complete identification of each gem, and the identification noted on the policy. The second type of insurance does not call for such an accurate listing, but the collector should be prepared to furnish complete information in the case of a loss. The methods of cataloguing discussed earlier should fill this need.

A collection is in reality a hobby, and can easily be likened to fishing or stamp collecting, etc. It can be pursued as a single hobby, or in conjunction with another. It can be the relaxation and diversion that the busy professional person needs at the end of a trying day.

Displaying Of Gems

The reasons for a collection as discussed above are valid, but they take into account the collector only. Such rewards for collecting really interest only the collector, but as soon as one includes other parties in his hobby, he opens a whole vista of possibilities for rewards to himself and others.

In order that other parties may enjoy a collection to the fullest, it must be displayed in a place or places available to the viewers. This may be done in one's home, with only a small case or cabinet, or the collection may be transported and displayed at various gatherings.

Throughout this country are numerous gem societies, membership in one will offer the faceter the opportunity to share ideas and experiences. Many of these societies have periodic shows to which the general public is invited. These shows are a wonderful opportunity to exhibit one's handiwork, and to see what others have done. Careful examination of other faceting exhibits will give the faceter new goals to attain, or be the basis of ideas that can be adapted to his needs.

Building Attractive Displays

If one is to take full advantage of the opportunity of displaying, regardless of where it is done, he must pay close attention to the art of arranging an attractive display. A case in which gems are strewn haphazardly is not attractive, and very little attention will be paid to it.

Arrangement Of A Display

The individual units of a display should be arranged so that the viewer may easily see all gems. No unit should hide another or a portion of another. Large gems or large groups of gems are best placed at the rear of the case.

Smaller units should be placed to the front. The rear units are best elevated, if possible, and the same might be true for those on either side of the case. The arrangement may follow geometric patterns, straight or curved lines, or other pleasing outlines. The important thing is to try to achieve an eye-catching arrangement. One may greatly benefit by carefully noting other displays, whether poorly or well done. The word here is showmanship; it is well chosen.

Labeling The Display

An unlabeled display is worse than no display. The viewer may go away having learned nothing, and may even feel cheated. If gems are worth displaying, they are worth identifying. If a faceter wishes others to view and enjoy his work, they have the right to know what they are seeing. Labels may be as simple or as elaborate as the collector may wish. The minimum label should be the name of the gem. If it is a single gem, a word such as AMETHYST should suffice. If one wishes to be more explicit he may state: QUARTZ, variety amethyst; Minas Geraes, Brazil. In the case of a collection of different cuts, the label could read: AMETHYST, Brazil, Portuguese cut, 177 facets. With a similar label for each unit in the display, the viewer now is oriented as to what he is seeing, and at the same time receives the message that the collector is trying to present.

There is nothing wrong with one label for two or more gems, as long as they have something in common. Color suites may have a single label denoting each species. Another method might be as illustrated in Figure 118. Here the labels under each gem denote the color varietal name. In the case of zircon and others few of the color varieties have individual names, and the single name of the gem species will suffice.

There is one inescapable fact regarding labels for faceted gems. If the exhibitor is not careful, the label will, because of its size, attract more attention than the gem. An exhibit that appears to be all labels will not receive much interest. It is far better to have labels too small than too large, but there must be labels.

The one unmeasurable criterion on a good display is good taste. Few people are born with the ability to create a tasteful display. Some learn it very rapidly but others must work hard at it. Every exhibitor should try to do the best he can at the moment, and always leave himself in the frame of mind to change his thinking if a better idea develops. The exhibitor that is never in a rut is the one the viewers seek out each time there is a display of his work.

After all the instructions herein are studied, and those found good are used, the faceter will find that the most potent teacher will be others. It will not matter greatly whether they are faceters or not. What any viewer says about one's handiwork should be carefully noted. What another faceter does should not be imitated faithfully, but certainly the best ideas of others are worth incorporating into one's technique. Only when one freely shares his experiences can he be in a position to learn from others. This sharing is the best teacher.

Appendix I

Species Descriptions

FOLLOWING ARE THE physical and optical characteristics of most of the gem minerals. Also included are the cutting and polishing behaviors, and the cutting and polishing laps that have been the most successful in the experience of the authors.

Comparable and more complete physical and optical characteristics are to be found in any good text on mineralogy. In some cases, those given here are reported differently. Brittleness and its opposite, toughness, are listed under fragility, with toughness being a low fragility and brittleness being a high fragility. The point at which these two theoretically overlap is listed as moderate.

The figures for birefringence and dispersion are expressed as refractive index decimals and as strong, weak, high, low, and medium. Most texts list only the refractive index.

Cutting angles are listed as the culet angle for the pavilion, and the crown angle for the crown. In the case of the culet angle, it is normally the lowest possible angle. The crown angle is usually the angle for the crown main facets. The cutting diagrams list all other angles as larger (plus) or smaller (less).

The cutting lap listed is usually the most reasonable grade of diamond or other abrasive. The polishing lap and polishing compound combination first listed is presumed to be the best, with others listed in descending usefulness.

ACTINOLITE

Calcium magnesium iron silicate
Hardness - 5 to 6
Specific Gravity - 3.0 to 3.3
Cleavage - perfect, very easy one direction
Fracture - uneven, moderately tough
Heat sensitivity - low

Monoclinic
Green
Refractive index - 1.61
Critical angle - 38°
Birefringence - .026, medium
Dispersion - none
Dichroic

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
tin	Linde A	normal
tin/lead	Linde A	normal

Miscellaneous information: Group One

The very easy cleavage demands extreme care and directional grinding and polishing. Cutting of facets across the end of the crystal is slower than along the sides. The corners will fray, and facets meeting at right angles are not recommended.

Faceting material comes from a single locality in Madagascar. A locality in Oregon produces fine single crystals that may contain small faceting areas.

AMBER

Oxygenated hydrocarbon
Hardness - 2 to 2½
Specific gravity - 1.096
Cleavage - none
Fracture - conchoidal, fairly tough
Heat sensitivity - high, melts just above dopping temperature

Amorphous
Yellow, red, orange
Refractive index - 1.54
Critical angle - 40½°
Birefringence - none
Dispersion - none

Cutting angles:
Culet - 43° Crown - 42°
Cutting lap - fine or extra fine

Polishing:

Lap	Agent	Speed
wax	Linde A	normal

Miscellaneous information: Group Three

Any heating, even below the melting temperature of about 150° centigrade, will drive off volatile materials and leave the piece weakened. The weakening results in the material being brittle. It gives less trouble than Group Three indicates. Facet cutting is slow as the lap tends to clog. Use copious amounts of lubricant. Polishing is slow with the wax lap, but a bit of extra time will produce a fine polish. A felt lap will polish faster, but the rounding of corners is excessive.

Good faceting material comes from the Baltic Sea region. Rough is ordinarily available in sizes up to two and three ounces. Some of it is very clear.

AMBLYGONITE

Lithium aluminum fluo-phosphate
Hardness - 6
Specific gravity - 3.0
Cleavage - perfect
two directions
Fracture - uneven
Heat sensitivity - low

Triclinic
Yellow, greenish, colorless
Refractive index - 1.58
Critical angle - 39°
Birefringence - .021, medium
Dispersion - none

Cutting angles:
Culet - 43° Crown - 42°
Cutting lap - fine or extra fine diamond

Polishing:

Lap	Agent	Speed
lead	Linde A	normal
tin/lead	Linde A	100 rpm

Miscellaneous information:

The perfect cleavage makes amblygonite slightly troublesome. A perfectly true grinding wheel of a fine grit will be satisfactory for preforming. If the cleavage gives trouble in facet cutting, use the extra fine lap. Polishing is best on the tin/lead lap at slow speed as the material tends to scratch at normal polishing speeds.

The finest material presently comes from Brazil. Nice material also comes from Burma. Pieces up to 100 carats are sometimes on the market, but flawless pieces over 25 carats are seldom available.

ANALCIME
(Analcite)

Sodium aluminum silicate
Hardness - 5 to 5½
Specific gravity - 2.22
Cleavage - none
Fracture - conchoidal, brittle
Heat sensitivity - low

Isometric
Colorless
Refractive index - 1.48
Critical angle - 42½°
Dispersion - none
Birefringence - weak

Cutting angles:
Culet - 44° Crown - 43°
Cutting lap - fine or extra fine diamond

Polishing:

Lap	Agent	Speed
"lucite"	cerium oxide	normal
tin/lead	Linde A	normal

Miscellaneous information:

A rare material in facet quality. It has little to recommend it as a gem except its rarity. Facet cutting and polishing seldom offer any problems. The greatest problem is obtaining facetable material.

Faceting material is found in limited amounts in Italy, Canada, and Michigan. Pieces are usually very small.

ANATASE

Titanium dioxide
Hardness - 6
Specific gravity - 3.8
Cleavage - perfect
two directions
Fracture - Subconchoidal, brittle
Heat sensitivity - low

Tetragonal
Brown, blue
Refractive index - 2.5
Critical angle - 24°
Birefringence - .056, strong
Dispersion - none

Cutting angles:
Culet 40° Crown - 30°
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal

Miscellaneous information:

This is a very rare material, and seldom found in facet grade. Facetable pieces are usually very small, and a fine or extra fine lap is advisable under the circumstances. Cutting and polishing characteristics are not fully known, but there are no reports of difficulties.

The only recent source of material is Brazil.

ANDALUSITE

Aluminum silicate
Hardness - 7 to 7½
Specific gravity - 3.2
Cleavage - distinct
one direction
Fracture - uneven, somewhat brittle
Heat sensitivity - low

Orthorhombic
Green, pink, violet, red
Refractive index - 1.64
Critical angle - 37½°
Birefringence - .01, weak
Dispersion - none
Trichroic - red, yellow, and green

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - medium diamond or
finer

Polishing:

Lap	Agent	Speed
tin	tin oxide	normal
tin/lead	Linde A	normal

Miscellaneous information:

The brittleness makes it sometimes difficult to cut gems with sharp corners. Pay particular attention to the cleavage. The emerald cut or some similar retangular cut is most logical. The material can be cut into rounds and ovals, but the tricolored look is sometimes not pleasing.

Brazil produces the finest and largest specimens. Fine flawless pieces up to 100 carats and larger are sometimes available.

ANGLESITE

Lead sulphate
Hardness - 2.7 to 3
Specific gravity - 6.3
Cleavage - perfect
two directions
Fracture - conchoidal, very brittle
Heat sensitivity - very high

Orthorhombic
Colorless, yellowish
Refractive index - 1.88
Critical angle - 32°
Birefringence - .017, medium
Dispersion - strong

Cutting angles:
Culet - 40° Crown - 38°
Cutting lap - loose grit on micarta or vinyl

Polishing:

Lap	Agent	Speed
wax	Linde A	normal

Miscellaneous information: Group Three

The extreme brittleness dictates no shock of any kind. Preforming on a perfectly smooth extra fine lap is satisfactory if extreme care is taken. The loose grit is the better choice. If chipping occurs, use tripoli on wax.

Finest faceting material is from a few locations in Africa. A recent source is Mexico. Material is usually in small pieces, but clarity is good.

ANHYDRITE

Calcium sulphate
Hardness - 3 to 3½
Specific gravity - 2.9
Cleavage - very perfect
three directions
Fracture - uneven, flexible
Heat sensitivity - very high

Orthorhombic
Colorless, purple
Refractive index - 1.57
Critical angle - 39½°
Birefringence - .043, strong
Dispersion - .013, low

Cutting angles:
Culet - 43° Crown - 42°
Cutting lap - wax with Linde A

Polishing:

Lap	Agent	Speed
wax	Linde A	normal

Miscellaneous information: Group Three

This material is very difficult to handle. It must be cut as well as polished on wax with Linde A. Any sawing must be done with a jeweler's saw lubricated with a very light oil. Preforming on a grinding wheel should not be attempted.

Only source of faceting material is various salt mines in Europe and the United States. Crystals and fragments are usually small and irregular. Clarity is usually good.

APATITE

Variable calcium phosphate
Hardness - 5
Specific gravity - 3.2
Cleavage - imperfect
Fracture - conchoidal, brittle
Heat sensitivity - high

Hexagonal
Green, pink, blue, yellow, colorless
Refractive index - 1.64
Critical angle - 37½°
Birefringence - .004, weak
Dispersion - .013, low
Some is dichroic

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - medium diamond or finer

Polishing:

Lap	Agent	Speed
vinyl	Linde A	normal
lead	Linde A	normal
tin/lead	Linde A	50 rpm

Miscellaneous information: Group Two

Apatite can at times be dopped with regular dopping wax, but it is safer to use a cold dopping cement. The mineral is variable in composition, and the cutting and polishing characteristics are quite variable. It is very susceptible to aggregation and flow scratches during polishing.

Fine clear yellow crystals come from Mexico. Nice green material comes from Madagascar and Canada; purple from Europe and Maine; brown and blue from Brazil; and blue-green from Burma. Pieces over 50 carats are not unusual, and most material is quite flawless.

APOPHYLLITE

Potassium fluo-calcium silicate
Hardness - 4½ to 5
Specific gravity - 2.4
Cleavage - very easy two directions
Fracture - uneven, brittle
Heat sensitivity - extreme

Tetragonal
Pink, greenish, colorless
Refractive index - 1.53
Critical angle - 41°
Birefringence - .002, low
Dispersion - none

Cutting angles:
Culet - 43° Crown - 42°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
tin/lead	Linde A	50 rpm

Miscellaneous information: Group Two

The cleavage of this material is very troublesome in all stages. The heat sensitivity has a direct bearing upon the cleavage. Extreme care must be taken during lapping. The slower speed gives the best polish.

Fine material comes from Brazil. Good rough comes from various locations in Oregon; also from some of the Eastern States, Nova Scotia, Scotland and Mexico. Clean pieces over 10 carats are seldom available.

ARAGONITE

Calcium carbonate
Hardness - 3½ to 4
Specific gravity - 2.94
Cleavage - distinct
one direction
Fracture - conchoidal, very brittle
Heat sensitivity - moderate

Orthorhombic
Colorless, yellow, greenish, violet
Refractive index - 1.53 & 1.68
Critical angle - 39°
Birefringence - .155, very strong
Dispersion - low
Strongly dichroic

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
wax	Linde A	normal
tin/lead	Linde A	50 rpm

Miscellaneous information: Group Two

The cleavage is not troublesome. The real problem is the brittleness. This material can be dopped with a low melting point wax, but a cold dop is far the safest. The optic axis should be oriented, but, as most crystals are very slender, the orientation may be impossible without extreme loss.

A few European localities furnish practically all the facet material.

AUGELITE

Aluminum phosphate
Hardness - 5
Specific gravity - 2.7
Cleavage - perfect
one direction
Fracture - conchoidal, brittle
Heat sensitivity - low

Monoclinic
Colorless
Refractive index - 1.57
Critical angle - 39½°
Birefringence - .014, medium
Dispersion - none

Cutting angles:
Culet - 43° Crown - 42°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
wax	Linde A	normal
tin/lead	Linde A	100 rpm

Miscellaneous information: Group One

This is a very rare material. The brittleness and cleavage are very troublesome. Facet cutting should be done with great care; loose grit on a plastic lap may be necessary. Polishing is somewhat easier.

The best location for faceting rough, the Champion Spark Plug sillimanite mine in the White Mountains of California, is now exhausted. Facetable pieces may be found in old collections. Small amounts of rough have been found in Sweden, Bolivia, and Africa. Pieces are always small.

AXINITE

Calcium aluminum boro-silicate
Hardness - 6½ to 7
Specific gravity - 3.3
Cleavage - distinct
one direction
Fracture - conchoidal, somewhat
brittle
Heat sensitivity - none

Triclinic
Plum blue, brownish
Refractive index - 1.68
Critical angle - 36½°
Birefringence - .01, weak
Dispersion - low
Strong dichroism, clear to brown

Cutting angles:
Culet - 42° Crown - 40°
Cutting lap- any grade of diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
typemetal	Linde A	normal
"lucite"	cerium oxide	normal

Miscellaneous information:

This mineral is seldom found in good crystals, and rarely in flawless pieces. It usually contains many impurities which sometimes give polishing troubles. On occasion more than one lap and agent combination may be needed on one stone. This material must be carefully oriented in order to get the finest colored gem.

California has produced a few specimens from various locations. Fine material comes from Baja, California, Mexico. The Mexican material sometimes is flawless up to 50 carats, and slightly flawed in pieces much larger.

AZURITE

Basic copper carbonate
Hardness - 3½ to 4
Specific gravity - 3.8
Cleavage - perfect
one direction
Fracture - conchoidal, slightly brittle
Heat sensitivity - low

Monoclinic
Deep blue, usually opaque
Refractive index - 1.73 to 1.83
Critical angle - 35°
Birefringence - .108, very strong
Dispersion - none

Cutting angles:
Culet - 41° to 35° Crown - 40°
Cutting lap - fine or extra fine
diamond, tends to clog lap

Polishing:

Lap	Agent	Speed
wax	Linde A	normal
tin/lead	Linde A	50 rpm

Miscellaneous information: Group Two

The deep color masks the high refractive index and the birefringence. The cutting angles above are not important, and should be lowered greatly in order to get light through the stone. The birefringence is very strong, but orienting the optic axis is not necessary because of the extreme depth of color. The prime requisite with this material is to cut it shallow enough in order to get light through it. Cutting is slow as it tends to clog the lap. Polishing is fairly rapid with either lap, but tin/lead at slow speed is best.

Fine transparent crystals come from the copper mines of Africa. Arizona produces fine crystals, but they lack the transparency of those from Africa. Some African crystals are as thick as one-half inch, but a stone of that depth would pass no light. The small crystals make the best gems.

BARITE

Barium sulphate
Hardness - 2½ to 3½
Specific gravity - 4.3 to 4.6
Cleavage - very easy
two directions
Fracture - uneven, brittle
Heat sensitivity - very high

Orthorhombic
Blue, brown, colorless
Refractive index - 1.63
Critical angle - 38°
Birefringence - .012, medium
Dispersion - low

Cutting angles:
Culet - 42° Crown 41°
Cutting lap - extra fine diamond at 50 rpm

Polishing:

Lap	Agent	Speed
wax	Linde A	normal
wax	Linde A	25 rpm

Miscellaneous information: Group Three

The cleavage and brittleness are very troublesome. Facet cutting is precarious, and may need to be done on plastic with loose grit or perhaps wax with tripoli. Polishing is rapid and gives less difficulty at slow speeds. A perfect polish is difficult to achieve.

Colorado produces a fine blue, a golden brown comes from South Dakota, and colorless is found in England and other countries. All locations produce clear pieces and crystals up to 100 carats or larger. Most pieces that size usually have flaws and cleavage cracks. A gem over ten carats is large.

BENITOITE

Barium titano-silicate
Hardness - 6 to 6½
Specific gravity - 3.6
Cleavage - poor
Fracture - conchoidal, tough
Heat sensitivity - none

Hexagonal
Colorless to deep blue
Refractive index - 1.76
Critical angle - 34½°
Birefringence - .05, strong
Dispersion - .047, high
Dichroic - blue to colorless

Cutting angles:
Culet - 41° Crown - 39°
Cutting lap - fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
"lucite"	cerium oxide	normal
tin	tin oxide	normal

Miscellaneous information:

This is an excellent gem. The optical properties make the round brilliants, especially the standard brilliant, the most responsive cut. This material gives very little trouble in facet cutting, except for the extremely small size. Polishing is sometimes difficult.

Facetable pieces are known from only one locality in San Benito County, California. Pieces have always been small; gems over one carat are rare.

BERYL

Beryllium aluminum silicate

Hexagonal

Gem varieties
- Aquamarine
- Emerald
- Goshenite
- Heliodor
- Morganite

Color
- Blue to greenish
- Green
- Colorless
- Golden to yellow
- Pink to peach color

Hardness - 7½ to 8
Specific gravity - 2.7
Cleavage - very imperfect one direction
Fracture - conchoidal, tough
Heat sensitivity - none

Refractive index - 1.58
Critical angle - 39½°
Birefringence - .006, weak
Dispersion - .014, low
Dichroic - strong to weak

Cutting angles:
- Culet - 43° Crown - 42°
- Cutting lap - any grade of diamond that seems advisable

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
"lucite"	cerium oxide	normal
tin	tin oxide	normal

Miscellaneous information:

Beryl seldom gives trouble at any stage. Emerald and other impure forms may be troublesome during polishing due to the flaws and cracks either separating or causing aggregation and flow.

This gem material is found in many localities, with Brazil furnishing excellent examples of most varieties. Fine morganite and aquamarine come from California and other states, as well as Madagascar, Africa, and Russia. The finest emeralds are from Colombia. Aquamarine, morganite, and goshenite may be purchased in pieces up to a number of hundred carats. Heliodor is seldom found in pieces over 50 carats. Emeralds are seldom on the market, and pieces are usually under five carats in weight.

BERYLLONITE

Sodium beryllium phosphate
Hardness - 5½ to 6
Specific gravity - 2.8
Cleavage - perfect, easy
two directions
Fracture - conchoidal, slightly brittle
Heat sensitivity - moderate

Orthorhombic
Colorless to pale yellow
Refractive index - 1.55
Critical angle - 40°
Birefringence - .01, weak
Dispersion - .014, low

Cutting angles:
Culet - 43° Crown - 42°
Cutting lap - medium diamond or finer

Polishing:

Lap	Agent	Speed
"lucite"	cerium oxide	normal
tin/lead	Linde A	100 rpm

Miscellaneous information: Group One

The cleavages are the most troublesome and should be handled carefully. Heat shock will open them easily. Facet cutting is not difficult. A dry polishing lap is disastrous, use a thin slurry. The metal lap seems to be best, but the plastic lap at normal or slow speeds will polish.

Found in only a few localities in Maine. Rough in sizes over 25 carats is unusual.

BORACITE

Magnesium chloro-borate
Hardness - 7 to 7½
Specific gravity - 2.9
Cleavage - none
Fracture - conchoidal, tough
Heat sensitivity - low

Isometric
Colorless, yellow, greenish
Refractive index - 1.66
Critical angle - 37°
Birefringence - none
Dispersion - none

Cutting angles:
Culet - 42° Crown - 40°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
tin	Linde A	normal

Miscellaneous information:

A rare material that makes a fine gem. It offers no serious problems at any stage. Polishing is usually rapid.

Most faceting material is from the various salt mines in Germany. The mineral is always in the form of crystals which seldom are over one-half inch across. The usual crystal size is about one-fourth inch.

BRAZILIANITE

Sodium aluminum phosphate
Hardness - 5½
Specific gravity - 2.9
Cleavage - perfect
one direction
Fracture - conchoidal, brittle
Heat sensitivity - moderate

Monoclinic
Yellow-green
Refractive index - 1.6
Critical angle - 38½°
Birefringence - .02, medium
Dispersion - low

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - medium diamond or finer

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
"lucite"	cerium oxide	normal
typemetal	Linde A	normal

Miscellaneous information: Group One

One of the newer gem materials with a fine yellow to green color. The cleavage and brittleness usually give no trouble. The cleavage plane may open with heat shock. Polishes with no difficulty; slow speed is not an advantage.

Faceting material comes only from Brazil and one location in New Hampshire. Brazilian crystals may run a number of hundred carats in weight, but these are seldom flawless. Only small areas of each crystal are clean enough to facet. Gems over 15 carats are considered of large size.

CALCITE

Calcium carbonate
Hardness - 3
Specific gravity - 2.7
Cleavage - very perfect
three directions
Fracture - conchoidal, brittle
Heat sensitivity - high

Hexagonal
Colorless, brown, orange, red
Refractive index - 1.48 and 1.65
Critical angle - 42½° (for 1.48)
Birefringence - .172, strong
Dispersion - none

Cutting angles:
Culet - 44° Crown - 43°
Cutting lap - extra fine diamond, at slow speed

Polishing:

Lap	Agent	Speed
wax	Linde A	normal
tin/lead	Linde A	50 rpm

Miscellaneous information: Group Three

A very beautiful gem can be produced from this material, but only with considerable difficulty. If possible, the optic axis should be oriented. The three directions of cleavage and the heat sensitivity give the most trouble. Cutting and polishing must be directional with the cleavage.

Fine orange-brown material comes from Baja, California, Mexico; yellow crystals from Florida; colorless material from many sources. Cobaltian calcite, a cobaltiferous massive variety of a fine rose-red color, comes from Spain. This variety is never perfectly clear. It is easier to work than the crystaline type, but the heat sensitivity is still a problem. Crystaline calcite is found in flawless crystals to a number of hundred carats in weight.

CARBORUNDUM

Silicon carbide
Hardness - 9½
Specific gravity - 3.1
Cleavage - none
Fracture - conchoidal, moderately tough
Heat sensitivity - none

Hexagonal
Blue-green to brownish
Refractive index - 2.65 to 2.7
Critical angle - 22°
Birefringence - .04, strong

Cutting angles:
Culet - 40° Crown - 38°
Cutting lap - fine diamond

Polishing:

Lap	Agent	Speed
tin	0-1 micron diamond	normal

Miscellaneous information:

This synthetic material is identical to moissanite, found in an Arizona meteorite. It grinds slowly on an ordinary grinding wheel, but facets will cut rapidly on a diamond lap. Sawing with the diamond saw is also rapid. Polishes fairly easily.

Produced in an electric furnace. At times, crystals large enough to produce one-half carat gems can be found in the clusters occasionally on the market.

CASSITERITE

Tin oxide
Hardness - 6 to 7
Specific gravity - 6.8 to 7.1
Cleavage - imperfect
Fracture - sub-conchoidal, tough
Heat sensitivity - none

Tetragonal
Colorless to yellow, brown
Refractive index - 1.99 to 2.09
Critical angle - 29½°
Birefringence - .096, strong
Dispersion - .071, high

Cutting angles:
Culet - 40° Crown - 36°
Cutting lap- medium diamond or finer

Polishing:

Lap	Agent	Speed
tin	Linde A	normal

Miscellaneous information:

Orientation of the optic axis is not imperative, but would be an advantage. Preforming or facet cutting is no problem. A thick slurry of polishing agent gives the better polish. Allowing the lap to become nearly dry may help. Polishes very slowly.

Best faceting material is from Bolivia. Crystals are color-zoned with black. Pieces are usually small, and gems over ten carats are rare.

CELESTITE

Strontium sulphate
Hardness - 3
Specific gravity - 3.9
Cleavage - perfect
two directions
Fracture - uneven, very brittle
Heat sensitivity - moderate to high

Orthorhombic
Colorless, pinkish, blue
Refractive index - 1.62
Critical angle - 38°
Birefringence - .009, weak
Dispersion - none

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - very fine diamond, slow speed

Polishing:

Lap	Agent	Speed
wax	Linde A	50 rpm

Miscellaneous information: Group Three

The cleavage is very troublesome and, coupled with the brittleness, makes it very difficult to handle in all stages. It seldom takes a good polish, but a slow speed on wax seems best.

Fine colorless to bluish crystals come from Ohio, Texas, California, and some foreign localities. Facetable crystals over 20 carats are unusual.

CERUSSITE

Lead carbonate
Hardness - 3½
Specific gravity - 6.5
Cleavage - distinct
two directions
Fracture - conchoidal, very brittle
Heat sensitivity - very high

Orthorhombic
Colorless, yellowish, smoky
Refractive index - 1.90 to 2.07
Critical angle - 31½°
Birefringence - .273, very strong
Dispersion - high

Cutting angles:
Culet - 41° Crown - 38°
Cutting lap - fine or extra fine diamond

Polishing:

Lap	Agent	Speed
wax	Linde A	normal

Miscellaneous information: Group Three

A cold dopping cement is imperative for this material. The cleavage gives difficulty and is probably affected by the brittleness. The optic axis should be oriented if possible. Facet cutting is not extremely difficult. Polishes with ease on wax. It also may polish on some of the soft plastic laps.

Fine material comes from Africa and Arizona. Flawless crystals weighing nearly a pound have been found in Africa.

CHONDRODITE

Magnesium fluo-silicate
Hardness - 6 to 6½
Specific gravity - 3.1 to 3.2
Cleavage - usually imperfect one direction
Fracture - sub-conchoidal, brittle
Heat sensitivity - high

Monoclinic
Light to dark brownish, red
Refractive index - 1.59 to 1.64
Critical angle - 38½°
Birefringence - .05, medium

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	100 rpm
tin	Linde A	normal

Miscellaneous information:

Because of the brittleness, use care in grinding to a preform and in facet cutting. Polishing is best on a tin/lead lap with Linde A at a slow speed. The dark colors mask the good optical properties. Small stones are usually the rule.

Good faceting rough comes only from the Tilly Foster Mine, New York. The mine is now closed, but pieces may on occasion be obtained from old collections.

CHRYSOBERYL

Beryllium aluminum oxide

Orthorhombic

Gem varieties
Ordinary
Alexandrite

Color
Yellow to greenish or brownish
Green and red

Hardness - 8½
Specific gravity - 3.6
Cleavage - indistinct
Fracture - conchoidal, moderate
Heat sensitivity - none

Refractive index - 1.75
Critical angle - 35°
Birefringence - .01, weak
Dispersion - .015, low

Cutting angles:
Culet - 42° Crown - 39°
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
tin	0-1 micron diamond	normal
tin/lead	Linde A	normal

Miscellaneous information:

An excellent gem. Handles easily in all stages, and polishes quickly on the tin and diamond combination. Polishes nicely but slowly with the tin/lead and Linde A combination.

Fine yellow crystals come from Brazil and Ceylon. The finest alexandrite is from Russia, with small amounts of lesser quality from Ceylon. Recently good alexandrite, in very small pieces, has come from Africa. Ordinary chrysoberyl can usually be found in nice clean crystals up to ten carats; larger sizes are rare. Any good alexandrite on the market is usually in pieces under three carats; those larger usually have a poor color change.

CINNABAR

Mercuric sulphide
Hardness - 2 to 2½
Specific gravity - 8.0
Cleavage - perfect
one direction
Fracture - uneven, very brittle
Heat sensitivity - very high

Hexagonal
Deep red
Refractive index - 3.0
Critical angle - 20°
Birefringence - .36, very strong
Dispersion - low

Cutting angles:
Culet - 39° or less Crown - 26°
Cutting lap - fine grit on micarta or vinyl

Polishing:

Lap	Agent	Speed
wax	Linde A	normal

Miscellaneous information: Group Three

The cleavage is not usually troublesome. The brittleness and the high heat sensitivity are the most difficult to cope with. This material is seldom clear, and if so, the deep color makes it imperative that the angles be lower than recommended above. The deep color removes the need for orienting the optic axis. It will sometimes lap on extra fine diamond. Facets take a high lustrous polish with no difficulty.

Good faceting material comes from Mexico and Nevada. China is good source, but it is difficult to obtain. Pieces seldom run over 15 carats. Gems should seldom be over one carat.

CLINOZOISITE

(See Epidote)

COLEMANITE

Calcium borate
Hardness - 4 to 4½
Specific gravity - 2.42
Cleavage - very perfect
two directions
Fracture - uneven, brittle
Heat sensitivity - high

Monoclinic
Colorless, yellowish
Refractive index - 1.59
Critical angle - 39°
Birefringence - .028, medium
Dispersion - low

Cutting angles:
Culet 43° Crown - 42°
Cutting lap - medium diamond or finer

Polishing:

Lap	Agent	Speed
wax	Linde A	normal
tin/lead	Linde A	100 rpm
"lucite"	cerium oxide	100 rpm

Miscellaneous information: Group Two

Facet cutting is not especially difficult as long as reasonable care is taken. The cleavage and brittleness combined make this difficult material to polish.

Facet material comes from a number of California localities. Crystals large enough to cut gems over five carats are very unusual.

CORDIERITE

(See Iolite)

CORUNDUM

Aluminum oxide

Hexagonal

Gem varieties
- Ruby
- Sapphire

Color
- Red
- Most colors except red

Hardness - 9
Specific gravity - 4
Cleavage - none, two parting directions on twinned stones
Fracture - uneven, tough
Heat sensitivity - none

Refractive index - 1.76
Critical angle - 34½°
Birefringence - .008, weak
Dispersion - .018, medium
Dichroic in deep colors

Cutting angles:
- Culet - 42° Crown - 40°
- Cutting lap - any grade of diamond

Polishing: all at normal speeds

Lap	Agent
tin	0-1 micron diamond
copper	0-1 micron diamond
typemetal	tripoli

Miscellaneous information:

This very durable gem is usually of fine color. The hardness gives some difficulty in all stages, but time and patience are the greatest assets in handling it. Typemetal and tripoli are really too slow for polishing, but the combination will help remove the greasy look after polishing with diamond.

Small sapphire crystals, seldom over five carats, come from Montana. Fine sapphire in sizes up to twenty carats comes from Asia and Australia. The finest ruby from Asia is sometimes on the market, but pieces are usually very small.

CROCOITE

Lead chromate
Hardness - 2½ to 3
Specific gravity - 5.9 to 6.1
Cleavage - indistinct one direction
Fracture - uneven, very brittle
Heat sensitivity - high

Monoclinic
Red-orange
Refractive index - 2.4
Critical angle - 29½°
Birefringence - .350, very strong
Dispersion - none

Cutting angles:
- Culet - 40° Crown - 32°
- Cutting lap - fine grit on micarta or vinyl

Polishing:

Lap	Agent	Speed
wax	Linde A	normal

Miscellaneous information: Group Three

This is very brittle material that must be subjected to no shock during cutting or polishing. It can stand some heat, but a cold dop is the safest course. Orientation of the optic axis is not advantageous because of the deep color. Lapping can be done on the extra fine lap, but fine grit micarta is safer. Polishing is difficult.

The only source of rough is Tasmania. Faceting material is usually small pieces seldom larger than five carats.

CUPRITE

Copper oxide
Hardness - 3½ to 4
Specific gravity - 6.14
Cleavage - interrupted one direction
Fracture - conchoidal, brittle
Heat sensitivity - extreme

Isometric
Deep red
Refractive index - 2.85
Critical angle - 21°
Birefringence - none

Cutting angles:
Culet - 39° Crown - 28°
Cutting lap - fine grit on micarta or vinyl

Polishing:

Lap	Agent	Speed
wax	Linde A	normal
felt	Linde A	normal
tin/lead	Linde A	25 rpm

Miscellaneous information: Group Two

The deep color masks the optical properties. The culet angle should be reduced to nearly the critical angle in order to get light through the stone. It is best cut as a tablet. Sawing and grinding should be held to a minimum or dispensed with. Facet cutting on the plastic laps is not difficult. An extra fine diamond lap will occasionally work. Polishing on wax is sometimes difficult.

The copper mines of Arizona are the most likely sources of facetable crystals. This is a very rare material in faceting grade, and sizes suitable to make even very small stones are seldom on the market.

DANBURITE

Calcium borosilicate
Hardness - 7
Specific gravity - 3
Cleavage - poor
Fracture - uneven, tough
Heat sensitivity - none

Orthorhombic
Colorless, yellow, brownish, pink
Refractive index - 1.63
Critical angle - 38°
Birefringence - .006, weak
Dispersion - .017, low

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
typemetal	Linde A	normal
tin/lead	Linde A	normal

Miscellaneous information:

Danburite handles easily and ordinarily offers no problems. It makes a very brilliant gem because of its extreme clarity.

The material presently on the market comes from Mexico. Japan produces small amounts of a buff colored material. Good shaped and clean crystal terminations over twenty-five carats are rare. Most pieces are about ten carats. The crystal termination from Mexico is very sharp and much of the clearest part is wasted as it is too thin.

DATOLITE

Calcium borosilicate
Hardness - 5 to 5½
Specific gravity - 2.9 to 3.0
Cleavage - none
Fracture - conchoidal, brittle
Heat sensitivity - low

Monoclinic
Colorless, pale green, yellowish, reddish, amethystine
Refractive index - 1.65
Critical angle - 37½°
Birefringence - .044, medium
Dispersion - .016, low

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - medium diamond or finer

Polishing:

Lap	Agent	Speed
"lucite"	tin oxide	normal
tin/lead	Linde A	100 rpm
vinyl	Linde A	normal

Miscellaneous information: Group One

Facet cutting is not difficult. The brittleness of this material gives trouble during polishing. For normal lap speeds, the vinyl lap appears best. The best polish is obtained on tin/lead or similar lap at 100 rpm or less.

The best facet grade material comes from Massachusetts, New Jersey, and Connecticut. Pieces are seldom over ten carats in weight.

DIAMOND

Carbon
Hardness - 10
Specific gravity - 3.52
Cleavage - perfect four directions
Fracture - conchoidal, tough
Heat sensitivity - none

Isometric
Colorless, brown, red, yellow, blue, green
Refractive index - 2.41
Critical angle - 24½°
Birefringence - none
Dispersion - .044, high

Cutting angles:
Culet - 40° Crown - 32°
Cutting and polishing lap - cast iron
Cutting and polishing agent - diamond

Miscellaneous information:

It is obvious that few amateurs will attempt cutting diamond, but a number have tried, and some have been successful. Special heavy equipment is necessary, and the lap wheel should turn about 3,000 rpm. High heat is necessary for polishing. Some of the faceting equipment presently on the market could possibly be adapted to cut diamonds. The most important adaptation would be to increase the weight and stability of all parts.

Cuttable diamonds, in the form of octahedral crystals, are not as high priced as might be thought. The best gem crystals are from Africa, while Brazil and India produce a small amount. Some cuttable crystals come from Arkansas.

DIOPSIDE

Calcium magnesium silicate
Hardness - 5 to 6
Specific gravity - 3.27
Cleavage - distinct
one direction
Fracture - uneven; moderately tough
Heat sensitivity - low

Monoclinic
Green, blue, yellow, colorless
Refractive index - 1.68
Critical angle - 37°
Birefringence - .029, medium
Dispersion - low
Trichroic in deep colors

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - medium diamond

Polishing:

Lap	Agent	Speed
lead	Linde A	normal
tin/lead	Linde A	100 rpm

Miscellaneous information:

Lapping across ends of crystal is slow, and surface tends to glaze. Under this condition, cutting may nearly cease. The best polish is achieved by using an extra fine lap as a pre-polish. The slow polish speed is best. This material is greatly susceptible to aggregation and flow at the normal polish speeds. At best, polishing is slow.

The finest green material comes from Finland and Madagascar. A nearly colorless material comes from Canada. Sizes up to 25 carats are usually available. The dark green, which is the most common, should not be cut into gems over four carats.

DIOPTASE

Copper silicate
Hardness - 5
Specific gravity - 3.3
Cleavage - perfect
one direction
Fracture - conchoidal, brittle
Heat sensitivity - low

Hexagonal
Emerald green
Refractive index - 1.66
Critical angle - 37½°
Birefringence - .053, strong
Dispersion - .022, medium

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - extra fine diamond, slow speeds

Polishing:

Lap	Agent	Speed
"lucite"	cerium oxide	normal
tin/lead	Linde A	100 rpm

Miscellaneous information: Group One

Dioptase should be lapped only on the extra fine lap, preferably at slow speeds. The brittleness and cleavage give real trouble on coarser grades of diamond. Polishing is best on the metal lap at a speed of 100 rpm or less.

Africa produces all of the faceting material, which is seldom available in pieces much over a carat.

DOLOMITE

Calcium magnesium carbonate
Hardness - 3½ to 4
Specific gravity - 2.8
Cleavage - very perfect
three directions
Fracture - subconchoidal, brittle
Heat sensitivity - extreme

Hexagonal
Colorless, greenish, pink
Refractive index - 1.5 to 1.68
Critical angle - 42°
Birefringence - .17, very strong
Dispersion - low

Cutting angles:
Culet - 43° Crown 42°
Cutting lap - extra fine diamond, slow speed

Polishing:

Lap	Agent	Speed
wax	Linde A	normal
tin/lead	Linde A	50 rpm

Miscellaneous information: Group Two

This is one of the very difficult materials to handle. The optic axis and the cleavages should be oriented. If reasonable precautions are used it may be ground on a fine lap, but extra fine is recommended. Polishing is excellent with the metal laps at 50 rpm.

The present source of facet rough is New Mexico. Pieces up to 25 carats have been available at times.

ENSTATITE

Magnesium silicate

Orthorhombic

Gem varieties
Enstatite
Enstatite-hypersthene

Color
Greenish brown, green
Reddish

Hardness - 5½
Specific gravity - 3.2
Cleavage - distinct
one direction
Fracture - uneven, moderately brittle
Heat sensitivity - moderate

Refractive index - 1.65
Critical angle - 37°
Birefringence - .010, medium
Dispersion - low

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - medium diamond or finer, tends to fray

Polishing:

Lap	Agent	Speed
tin	tin oxide	normal
tin/lead	Linde A	normal

Miscellaneous information:

This material has a tendency to fray on sharp corners during sawing and lapping. It polishes easily with a light touch and a very thin slurry. Most of the available material is deep colored, and sizes seldom run over 20 carats.

Greenish brown material comes from India. A small amount of green material comes from Africa.

EPIDOTE GROUP

Calcium iron aluminum silicate

Gem species
- Epidote (monoclinic)
- Clinozoisite (orthorhombic)
- Zoisite (orthorhombic)

Color
- Pistachio green, brown
- Yellowish to greenish
- Yellow, pink, blue, violet

Hardness - 6 to 7
Specific gravity - 3.25 to 3.5
Cleavage - perfect
two directions
Fracture - uneven, moderately brittle
Heat sensitivity - moderate

Refractive index - 1.75
Critical angle - 35°
Birefringence - .04, strong
Dispersion - .03, high
Trichroic

Cutting angles:
Culet - 42° Crown - 40°
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
typemetal	Linde A	normal
tin/lead	Linde A	normal

Miscellaneous information:

This is a variable group of minerals, all relatively easy to cut and polish. The cleavage may separate during heating for dopping. Worse than the cleavage is a twinning plane, found in a large percentage of specimens, which will separate with the slightest heat shock. Most specimens, except zoisite, are usually so dark that the fine optical characteristics are masked.

Fine epidote comes from Austria, Brazil, and California. Clinozoisite and yellowish zoisite come from Baja California, Mexico. The recent discovery in Tanzania, Africa of fine trichroic (blue, lavender, and orange) zoisite has produced pieces of excellent size. It makes very fine gems. Epidote is found in flawless, deep colored, crystals up to 25 carats in weight. Clinozoisite crystals are large, but a flawless gem of any size over one carat is very rare.

EUCLASE

Beryllium aluminum silicate
Hardness - 7½
Specific gravity - 3 to 3.1
Cleavage - very perfect
one direction
Fracture - uneven, brittle
Heat sensitivity - none

Monoclinic
Colorless, green, blue, yellow
Refractive index - 1.66
Critical angle - 36°
Birefringence - .02, medium
Dispersion - .016, low

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - fine or extra fine diamond

Polishing:

Lap	Agent	Speed
tin	tin oxide	normal
tin/lead	Linde A	normal

Miscellaneous information:

Care must be exercised to orient the cleavage away from the table. Otherwise the cleavage gives very little trouble. Polishing is easy.

Fine blue and straw-yellow material comes from Brazil. Flawless pieces over five carats are very rare.

FELDSPAR GROUP

Variable aluminum silicates - Most are triclinic

Gem species	Color
Albite	Colorless
Anorthite	Colorless
Microcline	Colorless
Orthoclase (monoclinic)	Yellow, colorless
Plagioclase	Pale yellow to colorless

Hardness - 5 to 7 (varies with species)
Specific gravity - 2.5 to 2.7
Fracture - uneven, moderately brittle
Cleavage - perfect
three directions
Heat sensitivity - low

Refractive index - 1.52 to 1.58
Critical angle - 41°
Birefringence - weak to medium
Dispersion - low

Cutting angles:
Culet - 44° Crown - 42°
Cutting lap - medium or extra fine diamond

Polishing:

Lap	Agent	Speed
"lucite"	cerium oxide	normal
tin/lead	Linde A	normal
tin	tin oxide	normal

Miscellaneous information:

This is a variable group of minerals showing remarkably similar cutting and polishing characteristics. The cleavage is not troublesome, and at times does not need to be oriented away from the table. Polishing is often quite difficult, with scratches and furrowing necessitating a change of lap.

Fine yellow orthoclase comes from Madagascar. Colorless material of other varieties comes from the United States and Canada. A nice yellowish material (probably labradorite) is found in Oregon and Utah. Most pieces of feldspar are small, with 25 carats being the usual maximum. The Madagascar and Oregon material is usually quite flawless; other materials are usually flawed or contain some inclusions.

FIBROLITE

(See Sillimanite)

FLUORITE

Calcium fluoride
Hardness - 4
Specific gravity - 3.2
Cleavage - perfect
four directions
Fracture - subconchoidal, brittle
Heat sensitivity - low

Isometric
Colorless, yellow, green, blue, pink, purple, etc.
Refractive index - 1.43
Critical angle - 44°
Birefringence - none
Dispersion - .006, low

Cutting angles:
Culet - 45° Crown - 43°
Cutting lap - medium or fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	100 rpm
lead	Linde A	normal
vinyl	Linde A	normal
wax	Linde A	normal

Miscellaneous information: Group Two

This is a gem material of low optical properties, but this is compensated for by the infinite color variety. The cleavage may give trouble in all stages including dopping. Cleavage must be carefully oriented away from the table. Preforming must be done on a perfectly true wheel. Polishing with metal laps is much more successful at a speed near 100 rpm.

Material comes from a large number of locations. A number of hues come from Illinois; a nice green from New York; and pink from Arizona. A fine green comes from Africa; and colorless from Canada. Pieces of nearly all colors may be found in sizes up to a number of hundred carats.

FRIEDELITE

Manganese chloro-silicate
Hardness - 4 to 5
Specific gravity - 3.07
Cleavage - imperfect
Fracture - conchoidal, tough
Heat sensitivity - moderate

Hexagonal
Reddish to orange
Refractive index - 1.63 to 1.66
Critical angle - not of importance as the material is translucent

Cutting angles:
Not important
Cutting lap - fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal

Miscellaneous information:

This is really a cabochon material, but it is sometimes cut into roses or freeform pendants. The material gives no real difficulty in any stage.

Faceting rough comes only from the Franklin Furnace District, New Jersey. Pieces are sometimes quite large.

GARNET GROUP

Silicates of various metals

Isometric

Gem varieties
- Almandine (iron aluminum)
- Andradite (calcium iron)
- Grossular (calcium aluminum)
- Pyrope (magnesium aluminum)
- Rhodolite (2 parts pyrope and 1 part almandine)
- Spessartite (manganese aluminum)
- Uvarovite (calcium chromium)

Colors
- Deep red, purplish red
- Green (demantoid), yellow, black
- Orange (hessonite), amber, pink
- Intense red
- Rose red, violet
- Orange, yellowish, brown, red
- Emerald green

Hardness - 6½ to 7½
Specific gravity - 3.5 to 4.2
Cleavage - none
parting - sometimes distinct
Fracture - subconchoidal, moderate to tough
Heat sensitivity - low or none

Refractive index - 1.7 to 1.9
Critical angle - 32° to 36°
Birefringence - none
Dispersion - high (variable)

Cutting angles:
Culet - 42° Crown - 37°
Cutting lap - medium, fine, or extra fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
typemetal	Linde A	normal
tin	tin oxide	normal
"lucite"	cerium oxide	normal

Miscellaneous information:

This group has most cutting and polishing characteristics in common. Many garnets are deep colored and flawed. The deep colors dictate a small gem. If large gems are to be cut in the deep colors, they will need to be cut flat, which will work against the fine optical properties. Flaws and impurities often give trouble in polishing.

Almandine comes from Madagascar, Ceylon, and India; pyrope is from Arizona; rhodolite is found in North Carolina, Australia, and Africa; spessartite is from California, Brazil, and Madagascar; hessonite is from Mexico, Canada, and Ceylon; uvarovite is from Canada. Other localities for each variety are also known.

The garnets are a well-known but little understood group. Most specimens contain impurities which may alter the cutting and polishing characteristics. The varieties of garnet intergrade with each other to make a very confusing situation at times.

The best known varieties are the deep red almandine and pyrope. Pyrope would be colorless without an impurity of chromium oxide. Both types are usually so deep colored that small gems are a necessity. The bright orange to red-orange of spessartite and the orange of hessonite are very popular with amateur gem cutters. The deep red form of spessartite is excellent as it has a higher refractive index (1.8) than other red varieties. The rose-red to violet rhodolite is also very popular. Demantoid nearly always contains impurities of byssolite, a form of asbestos. The near emerald green color of uvarovite is due to chromium oxide, but this time a green is produced instead of red. Gems of uvarovite rarely are a full carat in weight.

HAMBERGITE

Beryllium borate
Hardness - 7½
Specific gravity - 2.35
Cleavage - very perfect
two directions
Fracture - uneven, brittle
Heat sensitivity - low

Orthorhombic
Colorless, yellowish
Refractive index - 1.58
Critical angle - 39½°
Birefringence - .074, strong
Dispersion - .015, low

Cutting angles:
Culet - 43° Crown - 42°
Cutting lap - fine or extra fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	100 rpm
tin/lead	Linde A	normal
tin	tin oxide	normal
"lucite"	cerium oxide	normal

Miscellaneous information:
This is always a difficult material to handle. The two cleavages must be oriented, and then carefully watched during cutting and polishing. Cutting should be done only on the fine and extra fine laps. Polishing is usually difficult; a very thin slurry appears best. Slow speed is very helpful.
Madagascar is the only good source of facet material. Flawless pieces over ten carats are unusual. Most rough is cleaved and flawed.

HEMATITE

Iron oxide
Hardness - 5½ to 6½
Specific gravity - 5.1
Cleavage - poor
Fracture - uneven, tough
Heat sensitivity - low

Hexagonal
Opaque black
Refractive index - 3.0
Critical angle - not of importance as the material is opaque

Cutting angles:
Not of importance
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
tin	Linde A	normal
leather	cerium oxide	normal
wood	cerium oxide	normal

Miscellaneous information:
This opaque material has been a popular gem for many years, and is known by various names, including "Alaska Black Diamond". Material of gem quality is not known from Alaska. Virtually all gem quality material is from England. Polishing is the only difficulty encountered, and a good polish is hard to obtain. The splendent surface that results from a good polish is worth the effort. Stones are usually a rose cut or simply the crown of a common cut. Very large pieces up to a pound or more in weight are obtainable, but most gems are less than one inch in largest dimension, probably due to the difficulty in polishing.

HEXAGONITE
(See Tremolite)

HODGKINSONITE

Zinc mangano-silicate
Hardness - 4½
Specific gravity - 3.9
Cleavage - very perfect
one direction
Fracture - uneven, brittle
Heat sensitivity - moderate

Monoclinic
Pink, purple
Refractive index - 1.73
Critical angle - 35°
Birefringence - .022, medium
Dispersion - low

Cutting angles:
Culet - 41° Crown - 40°
Cutting lap - fine grit on micarta or vinyl

Polishing:

Lap	Agent	Speed
"lucite"	tin oxide	normal
vinyl	Linde A	normal
tin/lead	Linde A	100 rpm

Miscellaneous information:
Hodgkinsonite gives much difficulty in grinding for preforming, and in facet cutting because of the very easy cleavage. Usually very little trouble is encountered in polishing, especially on the metal lap at slow speed.

This material is found in faceting quality only at the zinc mines of the Franklin Furnace District, New Jersey. Pieces are small fragments.

IDOCRASE
(Vesuvianite)

Calcium aluminum silicate
Hardness - 6½
Specific gravity - 3.3 to 3.4
Cleavage - indistinct
Fracture - uneven, moderate
Heat sensitivity - low

Tetragonal
Greenish, yellow, blue
Refractive index - 1.71
Critical angle - 35½°
Birefringence - .005, weak
Dispersion - none

Cutting angles:
Culet - 42° Crown - 40°
Cutting lap - medium or fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
tin	tin oxide	normal
"lucite"	cerium oxide	normal

Miscellaneous information:
This material handles easily with care. Most rough is flawed, so flawless gems are small and rare.

The only source of rough is Canada.

INDERITE
KURNAKOVITE

Magnesium borates

Hardness - 2½
Specific gravity - 1.78 and 1.86
Cleavage - perfect
two directions
Fracture - conchoidal to uneven, moderate
Heat sensitivity - extreme

Inderite - Monoclinic
Kurnakovite - Triclinic
Colorless
Refractive index - 1.49
Critical angle - 42°
Birefringence - weak
Dispersion - none

Cutting angles:
Culet - 44° Crown - 43°
Cutting lap - extra fine diamond, lubricated with oil

Polishing:

Lap	Agent	Speed
wax	Linde A	normal

Miscellaneous information: Group Three

These two very unusual gem materials are found only at the borax mines at Boron, California. They have little to offer as a gem, except rarity. They are slightly water soluble minerals, and thus must be cut and polished using other than water as a coolant. Kerosene will do for lapping, and glycerine for polishing. Final cleaning of the gem should be done with acetone. If water is used in any stage, the material will take on surface deterioration which dulls the stone.

IOLITE
(Cordierite)

Magnesium aluminum silicate
Hardness - 7 to 7½
Specific gravity - 2.6
Cleavage - distinct
three directions
Fracture - uneven, fairly tough
Heat sensitivity - low

Orthorhombic
Intense blue to colorless
Refractive index - 1.55
Critical angle - 40°
Birefringence - .017, weak
Dispersion - low
Trichroic

Cutting angles:
Culet - 43° Crown - 42°
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
tin	tin oxide	normal

Miscellaneous information:

This mineral produces gems of low brilliance, and is best as one of the step cuts. The intense trichroism (blue, yellow, and colorless) calls for careful orientation to make the gem blue. The cleavage planes are usually not troublesome. Polishing is easiest with a very light touch, and a thin slurry.

The finest iolite comes from Ceylon and Madagascar. The bulk of the material on the market is from India. A small amount comes from locations in the United States. Most iolite is filled with flaws and cleavage cracks. Pieces of 50 carats or larger are not unusual, but flawless gems over five carats are seldom seen.

JADEITE

Sodium aluminum silicate
Hardness - 6½
Specific gravity - 3.3
Cleavage - none
Fracture - splintery, very tough
Heat sensitivity - none

Monoclinic
Colorless to dark green
Refractive index - 1.67
Critical angle - 37° (translucent)

Cutting angles:
Not important
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
tin	Linde A	normal

Miscellaneous information:

This material sometimes has small translucent portions that are suitable for faceting. Faceted gems always have a sleepy look. Jadeite gives the faceter little or no trouble in any stage.

Facetable material comes only from Burma. Small pieces may be found in the usual massive chunks intended for cabochon cutting.

KORNERUPINE

Magnesium aluminum silicate
Hardness - 6½
Specific gravity - 3.3
Cleavage - distinct
two directions
Fracture - conchoidal, moderately
brittle
Heat sensitivity - low

Orthorhombic
Green, brown, colorless
Refractive index - 1.66
Critical angle - 37°
Birefringence - .012, medium
Dispersion - none
Distinctly dichroic

Cutting angles:
Culet - 41° Crown - 40°
Cutting lap - medium diamond or
finer

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
tin	Linde A	normal

Miscellaneous information:

Rough of kornerupine is usually not available, but poorly cut stones are cheap enough that they may be recut to advantage. The cleavage gives trouble when preforming rough, but is not troublesome when recutting native cut stones. If possible, the dichroism should be oriented. Polishing is usually easy.

Rough comes from Madagascar and Ceylon; cut stones are usually from Ceylon. Cut stones to be found on the market seldom are over five carats. Rough pieces usually are not larger.

KYANITE

Aluminum silicate
Hardness - 4 and 7 (varies with faces)
Specific gravity - 3.5 to 3.6
Cleavage - very perfect
two directions
Fracture - splintery, brittle
Heat sensitivity - low

Triclinic
Blue, greenish blue
Refractive index - 1.72
Critical angle - $35\frac{1}{2}^{o}$
Birefringence - .012, medium
Dispersion - .011, low
Trichroism - distinct

Cutting angles:
Culet - 42° Crown - 40°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
tin	Linde A	normal
tin/lead	Linde A	normal

Miscellaneous information: Group One

This is a very difficult material to handle. Cutting and polishing must always be done in line with the pronounced cleavage that lies parallel to the widest side of the crystal. Any partially opened cleavages, even if completely buried within the stone, will usually open during some stage. The cleavage plane must be carefully oriented. Stones should not have sharp corners as they will tear. The emerald cut is the ideal rectangle for this material. Round brilliants are satisfactory. When sawing kyanite the hard crystal face (7) should always be placed in contact with the saw table. If the cut is across the crystal the saw should enter the soft face, otherwise the piece will shatter. If the cut is to be lengthwise of the crystal, the blade should enter so that its side is parallel to the cleavage plane. See figure 78.

A fine blue and green bi-colored material comes from Africa. A fine deep blue comes from Brazil; light blue from North Carolina. Crystals and pieces sometimes run over a hundred carats, but flawless areas are seldom over 20 carats.

LAZULITE

Iron aluminum magnesium phosphate
Hardness - 5
Specific gravity - 3.1
Cleavage - none
Fracture - uneven, tough
Heat sensitivity - moderate

Monoclinic
Blue
Refractive index - 1.63
Critical angle - 38°
Birefringence - .031, medium
Dichroic

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal

Miscellaneous information:

This is a unique rare gem material that gives very little trouble at any stage. Facetable pieces come only from Brazil, and are always small.

LEGRANDITE

Zinc arsenate
Hardness - 5
Specific gravity - 4.01
Cleavage - not troublesome
one direction
Fracture - uneven, very brittle
Heat sensitivity - moderate

Monoclinic
Yellow to colorless
Refractive index - 1.71
Critical angle - 36°
Birefringence - .039, medium
Dispersion - medium
Trichroic - colorless to yellow

Cutting angles:
Culet - 42° Crown - 40°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	50 rpm

Miscellaneous information:

Faceting information on this rare material is sketchy, but it dops with ordinary wax if care is used. It will saw and grind on a very true blade or wheel, but as the material is fairly soft, sawing and grinding should be held to a minimum and removal of excess material can be done on the fine or extra fine lap. The latter is preferred. Facet cutting is smooth and polishing is somewhat slow. This material tends to scratch at normal speeds on the tin/lead lap, but takes a good polish at about 50 rpm.

This is a relatively new mineral, discovered in 1932, and was known only as a single specimen for over 30 years. In the early 1960's it was found in good quantity at Mapimi, Durango, Mexico. Pieces are sometimes very clear, but are seldom over 1/8" in smallest dimension.

LEUCITE

Potassium aluminum silicate
Hardness - 5½ to 6
Specific gravity - 2.5
Cleavage - imperfect
Fracture - conchoidal, moderately
brittle
Heat sensitivity - low

Isometric
Colorless
Refractive index - 1.50
Critical angle - 42°
Birefringence - .001, weak
Dispersion - low

Cutting angles:
Culet - 44° Crown - 43°
Cutting lap - fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
tin/lead	Linde A	100 rpm
lead	Linde A	normal
"lucite"	cerium oxide	normal

Miscellaneous information:

This material gives little difficulty in handling; the greatest problem is finding facetable rough. Polishing should be done with a thick slurry, and the lap should never be allowed to dry.

The best present source of material is Italy. Flawless crystals over one-half inch are rare.

LUDLAMITE

Iron manganese magnesium phosphate
Hardness - 3½
Specific gravity - 3.1
Cleavage - perfect
one direction
Fracture - splintery, somewhat
flexible
Heat sensitivity - high

Monoclinic
Green
Refractive index - 1.65
Critical angle - 37½°
Birefringence - .044, strong

Cutting angles:
Culet - 42° Crown - 40°
Cutting lap - fine grit on micarta or vinyl

Polishing:

Lap	Agent	Speed
wax	Linde A	normal

Miscellaneous information: Group Two

The one perfect cleavage of ludlamite is very troublesome. The slightest shock will open it. Sawing should be done only with a jewelers saw and oil. Preforming should not be attempted. Facet cutting should be directional and done with extreme care. Polishing is comparatively easy, but should be directional with the cleavage.

The only source of facetable crystals is Idaho. Crystals seldom weigh over ten carats. Clarity is sometimes excellent.

MAGNESITE

Magnesium carbonate
Hardness - 3½ to 4½
Specific gravity - 3.1
Cleavage - perfect
three directions
Fracture - flat conchoidal, brittle
Heat sensitivity - extreme

Hexagonal
Colorless
Refractive index - 1.5 and 1.7
Critical angle - 42° and 36°
Birefringence - .202, very strong
Dispersion - low

Cutting angles:
Culet - 43° Crown - 42°
Cutting lap - extra fine diamond, slow speed

Polishing:

Lap	Agent	Speed
wax	Linde A	normal
tin/lead	Linde A	50 rpm

Miscellaneous information: Group Two

The cleavage must be carefully oriented. The optic axis should be oriented also, but the cleavages should get prime consideration. As the material comes only in cleaved fragments, gems are best cut as rectangles, and complete preforming is not really necessary. It is very difficult at best. Cutting should be done on the extra fine lap. It might be possible to do so on a coarser lap at slow speed. The best polish is obtained with the metal lap at about 50 rpm.

Present source of facet material is Brazil. Pieces of any size are very rare; twenty carats being the usual maximum.

MARCASITE

(See Pyrite)

MICROLITE

Calcium tantalate
Hardness - 5½
Specific gravity - 5.5
Cleavage - indistinguishable
Fracture - subconchoidal, brittle
Heat sensitivity - low

Isometric
Yellow, brown, red
Refractive index - 1.93
Critical angle - 30°
Birefringence - none
Dispersion - low

Cutting angles:
Culet - 41° Crown - 37°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
tin	Linde A	normal
tin/lead	Linde A	normal

Miscellaneous information:
This is a very rare material in facet grade. Clear material is known only from Virginia, and the mine has been closed for a number of years. Microlite offers no real cutting or polishing problems for those fortunate enough to procure rough. Most pieces are under five carats in weight.

MOLDAVITE
(See Obsidian)

NATROLITE

Sodium aluminum silicate
Hardness 5 to 5½
Specific gravity - 2.2 to 2.5
Cleavage - perfect
two directions
Fracture - uneven, moderately brittle
Heat sensitivity - high

Orthorhombic
Colorless
Refractive index - 1.48
Critical angle - 42½°
Birefringence - none
Dispersion - none

Cutting angles:
Culet - 44° Crown - 43°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
"lucite"	cerium oxide	normal
tin/lead	Linde A	100 rpm

Miscellaneous information: Group One
Crystals must be carefully oriented for the two cleavages. Heating must be done very carefully, and a cold dop is the safest course. Facet cutting can usually be done without mishap. The best polish is obtained on the metal lap at about 100 rpm.

Facetable crystals come from California, Montana, and New Jersey. Pieces are usually small and slightly flawed. Crystals or pieces over five carats are unusual.

OBSIDIAN
(and Tektite)

Highly variable volcanic glass
Hardness - 5½
Specific gravity - 2.3 to 2.6
Cleavage - none
Fracture - conchoidal, very brittle
Heat sensitivity - Usually moderate

Amorphous
Black, grey, green
Refractive index - 1.4 to 1.6
Critical angle - 42½°
Birefringence - none
Dispersion - none

Cutting angles:
Culet - 44° Crown - 43°
Cutting lap - medium grade diamond or finer

Polishing:

Lap	Agent	Speed
"lucite"	cerium oxide	normal
tin/lead	Linde A	normal
tin	tin oxide	normal

Miscellaneous information: Group One

This material is quite variable, and can give trouble in many ways. The lighter shades produce nice gems.

Obsidian comes from many localities, mainly Oregon, and other western states. Moldavite, a green, is from Europe. Tektite, an opaque black, is usually of Asiatic origin.

OPAL

Hydrous silicon dioxide

Amorphous

Gem varieties
Common (including Hyalite)
Cherry (transparent)
Fire (transparent)
Jelly (other than red)
Precious (usually not transparent)

Color
Colorless to gray
Orange, red -- no color play
Orange, red -- with color play
Clear with color play
Colorless to gray with color play

Hardness - 5 to 6½
Specific gravity - 1.9 to 2.3
Cleavage - none
Fracture - conchoidal, very brittle
Heat sensitivity - moderate to high

Refractive index - 1.45
Critical angle - 43½°
Birefringence - none
Dispersion - none

Cutting angles:
Culet - 44° Crown - 43°
Cutting lap - medium grade diamond or finer

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	100 rpm
"lucite"	cerium oxide	normal
tin/lead	Linde A	normal

Miscellaneous information: Group One

Some specimens of opal are easy to work, while others offer a maximum of difficulties. Grinding must be done with care on a true wheel. Lapping is not critical. The polishing lap should not have been used previously for a harder material; the metal lap at reduced speed is best.

The finest fire and cherry facet rough is from Mexico. Fine jelly comes from Australia and Honduras. Other localities have produced facet grade opal. Pieces of opal from Australia and Mexico may be 100 carats or larger.

PERIDOT

Magnesium iron silicate
Hardness - 6½ to 7
Specific gravity - 3.3
Cleavage - indistinct
Fracture - conchoidal, tough
Heat sensitivity - low

Orthorhombic
Green, greenish brown, brown
Refractive index - 1.67
Critical angle - 37°
Birefringence - .038, medium
Dispersion - .02, medium

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - medium or extra fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
tin/lead	Linde A	100 rpm
lead	Linde A	normal
tin	tin oxide	normal
"lucite"	cerium oxide	normal

Miscellaneous information:

Peridot is a very fine gem. It gives little or no trouble during preforming or cutting, but can be very unpredictable in polishing. There is no one lap and agent combination that will work for most stones. Some faceters keep the surface tension of the polishing agent low by adding a detergent. Others add vinegar or muriatic acid. Both methods work at times. Tin/lead at 100 rpm has been very successful. When all else fails, 0-1 micron diamond on tin will usually polish the stone.

Fine weathered chunks come from Arizona and Burma, some of which will weigh as much as 100 carats. The usual maximum is about half that figure. Excellent crystals come from the island of St. John in the Red Sea, but the size of these is seldom over 20 carats. The Red Sea material is much less flawed than the Arizona material.

PETALITE

Lithium aluminum silicate
Hardness - 6 to 6½
Specific gravity - 2.4
Cleavage - perfect
one direction
Fracture - uneven, brittle
Heat sensitivity - low

Monoclinic
Colorless, greenish, reddish
Refractive index - 1.50
Critical angle - 42°
Birefringence - .012, medium
Dispersion - none

Cutting angles:
Culet - 43° Crown - 42°
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
"lucite"	cerium oxide	normal
tin/lead	Linde A	100 rpm

Miscellaneous information:

Petalite makes a very brilliant clear gem. It gives no real problem from its cleavage or brittleness with careful handling. Polishing is best with the metal lap at reduced speed.

The present source of material is from Australia. Pieces are small, seldom over 15 carats, and usually flawed.

PHENACITE

Beryllium silicate
Hardness - 7½ to 8
Specific gravity - 3.0
Cleavage - distinct
two directions
Fracture - conchoidal, tough
Heat sensitivity - none

Hexagonal
Yellowish, pinkish, colorless
Refractive index - 1.66
Critical angle - 37°
Birefringence - .02, medium
Dispersion - .015, low

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
tin	tin oxide	normal

Miscellaneous information:

This makes a very brilliant gem, and gives no trouble during any stage of faceting with the exception that it polishes slowly.

The best facet rough is from Brazil. Some occasionally comes from Colorado. Phenacite, when facet grade, is exceedingly clear. Most crystals are partially flawed, and seldom weigh over 35 carats. A five carat gem is unusual.

PHOSGENITE

Lead chlorocarbonate
Hardness - 2 to 3
Specific gravity - 6.13
Cleavage - distinct
two directions
Fracture - conchoidal, brittle
(also sectile)
Heat sensitivity - extreme

Tetragonal
Yellowish, smoky, colorless
Refractive index - 2.1
Critical angle - 28½°
Birefringence - .026, medium
Dispersion - high

Cutting angles:
Culet - 40° Crown - 36°
Cutting lap - loose grit on micarta
or vinyl

Polishing:

Lap	Agent	Speed
wax	Linde A	normal
wax	Linde A	50 rpm

Miscellaneous information: Group Three

Phosgenite will produce a very brilliant gem, but not without difficulty. Trim sawing is dangerous; preforming on a true fine wheel is possible. The cleavage is troublesome, but the sectility will sometimes give it some toughness. Light pressure is needed for facet cutting on the plastic laps with loose grit. Polishing on wax is slow with pitting being a problem.

Rough presently comes only from Sardinia. Pieces are seldom over 15 carats.

PHOSPHOPHYLLITE

Zinc phosphate
Hardness - 3 to 4½
Specific gravity - 3.08
Cleavage - very perfect
two directions
Fracture - splintery, brittle
Heat sensitivity - moderate

Monoclinic
Light blue
Refractive index - 1.5 to 1.6
Critical angle - 39°
Birefringence - .021, medium

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - wax only, with tripoli or tin oxide

Polishing:

Lap	Agent	Speed
wax	Linde A	normal

Miscellaneous information:

This is a very difficult material to handle in any faceting stage. The cleavage is very troublesome. Dopping may be done with low melting point wax, but a cold dop is the best course. During facet cutting, the individual facets are best polished immediately and then coated with cellulose acetate to retard opening of cleavages.

Bolivia is the only present source of fine clear crystals.

POLLUCITE

Cesium aluminum silicate
Hardness - 6½
Specific gravity - 2.8 to 2.9
Cleavage - none
Fracture - conchoidal, brittle
Heat sensitivity - low

Isometric
Yellowish, pinkish, colorless
Refractive index - 1.52
Critical angle - 41°
Birefringence - none
Dispersion - .014, low

Cutting angles:
Culet - 43° Crown - 42°
Cutting lap - medium diamond or finer

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
"lucite"	cerium oxide	normal

Miscellaneous information:

The brittleness demands care during preforming and cutting. Polishing is easy on either lap, with the metal lap preferred. Material is rare and usually included with globular white particles.

The only rough available is from Maine and Connecticut. Pieces are small, seldom over ten carats.

PREHNITE

Calcium aluminum silicate
Hardness - 6 to 6½
Specific gravity - 2.8 to 2.95
Cleavage - indistinct
Fracture - uneven, tough
Heat sensitivity - none

Orthorhombic
Light green
Refractive index - 1.63
Critical angle - 38°
Birefringence - .033, medium
Dispersion - none

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
tin	Linde A	normal
vinyl	Linde A	normal

Miscellaneous information:

This material is seldom clear, and its inclusions give gems a sleepy look. It gives virtually no trouble in any phase of faceting.

Fine rough comes from Scotland. Most of the rough on the market is from New Jersey. Small, virtually clear pieces have come from Baja California, Mexico. Pieces of prehnite are sometimes large, but areas clear enough to facet seldom weigh more than ten carats.

PROUSTITE

Silver arsenic sulphide
Hardness - 2 to 2½
Specific gravity - 5.5
Cleavage - distinct
one direction
Fracture - conchoidal, very brittle
Heat sensitivity - extreme

Hexagonal
Deep red
Refractive index - 2.79 to 3.08
Critical angle - 21°
Birefringence - .297, very strong
Dispersion - low

Cutting angles:
Culet - 40° or less Crown - 30°
Cutting lap - wax with tripoli

Polishing:

Lap	Agent	Speed
wax	Linde A	normal

Miscellaneous information: Group Three

This is a very difficult material to work with. Sawing is very difficult. Preforming must be done with extreme care. Lapping should be done on wax with tripoli. Loose grit on micarta is possible but not advisable. Polishing is fast on wax with Linde A. The material is usually so dark that the culet angles should be lowered to about 30°. Clear gems are very beautiful.

Facet rough comes only from Chile and Germany. Chunks of proustite up to a number of ounces have been found, but the clear areas within them seldom weigh over 25 carats. A good gem usually does not weigh over five carats. Larger gems are too dark.

PYRITE

Iron sulphide
Hardness - 6 to 6½
Specific gravity - 5.0
Cleavage - indistinct
Fracture - conchoidal, brittle
Heat sensitivity - high

Isometric
Bright yellow, with metallic luster
Refractive index - opaque

Cutting angles:
Not of importance
Cutting lap - fine diamond seems best

Polishing:

Lap	Agent	Speed
wax	Linde A	normal
wood	Linde A	normal
felt	Linde A	normal

Miscellaneous information:

This is another opaque mineral that has been popular as a faceted gem. It is known in the jewelry trade as "marcasite" which is a misnomer. The material is very brittle, and must be heated very carefully. It will lap nicely on a fine or extra fine lap; the latter is preferred but it tends to clog the lap. It is difficult to polish. The cut used is a rose or the crown of a standard gem.

Pyrite is found in most mines containing metallic ores, but pieces suitable and pure enough to cut are rare. Arizona and Utah are the most common localities.

PYROXMANGITE

Manganese iron silicate
Hardness - 5½ to 6
Specific gravity - 3.8
Cleavage - perfect
two directions
Fracture - uneven, brittle
Heat sensitivity - low

Triclinic
Rose red
Refractive index - 1.75
Critical angle - 35°
Birefringence - .01, weak

Cutting angles:
Culet - 41° Crown - 40°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal

Miscellaneous information:

Preforming of this material is precarious and not advisable. The cleavage opens very easily during facet cutting. Directional cutting is necessary. Extreme care must be exercised at all times during this stage. Polishing is much easier with a good polish easily obtained.

Faceting rough comes from only one location in Japan. Crystals over one carat in weight are very rare.

QUARTZ

Silicon dioxide

Hexagonal

Gem varieties
- Amethyst
- Citrine
- Rose quartz
- Smoky quartz
- Rock crystal
- Vermarine

Color
- Purple
- Yellow to orange
- Pink
- Gray to black
- Colorless
- Green

Hardness - 7
Specific gravity - 2.66
Cleavage - none
Fracture - conchoidal, moderately brittle
Heat sensitivity - low

Refractive index - 1.55
Critical angle - 40°
Birefringence - .009, weak
Dispersion - .013, low

Cutting angles:
- Culet - 43° Crown - 42°
- Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
"lucite"	cerium oxide	normal
tin/lead	Linde A	normal
tin	Linde A	normal

Miscellaneous information:

Quartz is a very common mineral, and because of its many color varieties it is very popular with both amateur and professional. Everyone knows and has admired amethyst. Citrine and smoky quartz have masqueraded for many years as "golden topaz" and "smoky topaz". The fraudulent misnomers are finally disappearing.

Even though quartz is slightly brittle, preforming and facet cutting are quite easy. Polishing on the "lucite" lap is sometimes troublesome. In this case, one of the metal laps should do the job.

Good gem material comes from many locations. Those of most importance are listed. Brazil is the best supply of amethyst with Arizona producing some. Brazil also produces the best citrine, but this is a heat treated amethyst. Natural citrine comes from Madagascar and Mexico. Excellent rose and smoky material comes from Brazil and some of our western states. A newly recognized clear pink, called pink quartz, comes from Madagascar and Brazil. The unusual green material, known as vermarine, is a heat treated amethyst, and comes from a single locality in Brazil.

Smoky, rose, and citrine are often available in pieces up to 1000 carats or more. Amethyst is usually available in pieces up to 100 carats. Vermarine is seldom found larger than 25 carats.

REALGAR

Arsenic sulfide
Hardness - 1½ to 2
Specific gravity - 3.56
Cleavage - indistinct
Fracture - conchoidal, very brittle
Heat sensitivity - extreme

Monoclinic
Red to orange-red
Refractive index - 2.6
Critical angle - 22°
Birefringence - .16, strong
Dispersion - strong

Cutting angles:
Culet - 40° Crown - 31°
Cutting lap - loose grit on vinyl

Polishing:

Lap	Agent	Speed
wax	Linde A	25 rpm

Miscellaneous information: Group Three

This material offers the utmost in brittleness. Facet corners and junctions chip seemingly without any reason. Stones with 90° corners are not recommended. Preforming is best done on the cutting lap, as any grinding of any kind is disastrous. A cold dop is imperative. It is very possible that the vinyl lap above will not work, and wax with tripoli may need to be used for facet cutting. The culet angle may need to be lowered to near the critical angle because of the deep color. Polishing is rapid. Transfer and remove a stone with extreme care.

RHODIZITE

Aluminum beryllium borate
Hardness - 8
Specific gravity - 3.3
Cleavage - none
Fracture - conchoidal, somewhat brittle
Heat sensitivity - moderate

Isometric
Yellowish, colorless
Refractive index - 1.69
Critical angle - 36½°
Birefringence - none
Dispersion - none

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal

Miscellaneous information:

Rhodizite is one of the rarest of gem materials. It gives very little trouble in any faceting stage. The hardness has some effect on the brittleness. Polishing is not difficult.

The present supply is from Madagascar. Pieces are extremely small, and seldom yield gems of one carat.

RHODOCHROSITE

Manganese carbonate
Hardness - 3½ to 4½
Specific gravity - 3.4 to 3.6
Cleavage - perfect
three directions
Fracture - uneven, brittle
Heat sensitivity - moderate

Hexagonal
Rose red to pink
Refractive index - 1.60 and 1.82
Critical angle - 38½° (33½°)
Birefringence - .22, very strong
Dispersion - none

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - extra fine diamond is best; fine or medium are possible

Polishing:

Lap	Agent	Speed
wax	Linde A	normal
tin/lead	Linde A	100 rpm

Miscellaneous information: Group Two

This material must be handled with care, but it is not as precarious as might be assumed from the characteristics. It may be sawed and preformed safely. Cutting may be done on a fine lap, but the extra fine is recommended. The cleavages must be oriented. The optic axis should also be oriented. Polishing is easy and the results are good on either lap, but the wax lap rounds facets. Rough is seldom flawless, but flawed gems are beautiful.

Colorado produces fine rough. An excellent botryoidal material comes from Africa. Pieces up to ten carats in weight are sometimes on the market. Gems weighing as much as 15 carats have been cut from larger pieces. Few gems over five carats are flawless.

RHODONITE

Manganese metasilicate
Hardness - 5½ to 6½
Specific gravity - 3.4 to 3.6
Cleavage - very perfect
two directions
Fracture - subconchoidal, brittle
Heat sensitivity - low

Triclinic
Pink to rose red
Refractive index - 1.72 to 1.74
Critical angle - 35½°
Birefringence - weak
Dispersion - none

Cutting angles:
Culet - 42° Crown - 40°
Cutting lap - loose grit on micarta or vinyl

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal

Miscellaneous information: Group One

Rhodonite is a very shock sensitive material. It must be sawed carefully and preformed only on a fine grit wheel that is in perfect balance. Both are best dispensed with. Facets must be cut with the cleavage direction always in mind. Cutting with an extra fine diamond lap is sometimes possible. Use extreme care in all cutting stages. Avoid sharp corners as much as possible. Polishing is somewhat easier, and is best on a very true lap with little or no scoring.

Faceting material comes from New Jersey and Australia. Japan is a recent source. All pieces are very small, seldom over five carats.

RUTILE

Titanium dioxide
Hardness - 6 to 6½
Specific gravity - 4.25
Cleavage - distinct
two directions
Fracture - subconchoidal, fairly tough
Heat sensitivity - low

Tetragonal
Deep red, black
Refractive index - 2.61 and 2.90
Critical angle - 21°
Birefringence - .287, very strong
Dispersion - .30, very high
Dichroic

Cutting angles:
Culet - 40° Crown - 30°
Cutting lap - easily cut on medium diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
tin	Linde A	normal

Miscellaneous information:

The handling of rutile is interesting; sawing, preforming and lapping have a tendency to cause the surface to glaze and pit. A pitted facet surface polishes out easily, but the finest possible cutting lap should be used before polishing. Synthetic material should be carefully oriented to get the maximum from the optical properties. It is best to buy preforms from a reputable dealer. Natural rutile is always very dark and the above angles are too great. It is best cut at or near the critical angle, or as a tablet.

Natural material from Brazil is seldom over 15 carats in weight. As the resultant gems must be small, crystals less than 10 carats are very satisfactory. Synthetic material is best known as the colorless "Titania". Orange, blue, and other colors have been recently introduced.

SCAPOLITE

Aluminum silicate
Hardness - 5 to 6
Specific gravity - 2.6 to 2.7
Cleavage - indistinct
two directions
Fracture - conchoidal, somewhat brittle
Heat sensitivity - low

Tetragonal
Yellow, greenish, pink
Refractive index - 1.56
Critical angle - 40°
Birefringence - .022, medium
Dispersion - .017, low

Cutting angles:
Culet - 43° Crown - 42°
Cutting lap - medium diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
lead	Linde A	normal
"lucite"	cerium oxide	normal

Miscellaneous information:

Scapolite offers very little trouble at any stage.

Good faceting rough comes from Madagascar and Brazil. Fine yellow pieces come from Rhodesia. Pieces up to 100 carats or larger appear on the market from time to time, but these are usually flawed, and clean pieces over 25 carats are unusual.

SCHEELITE

Calcium tungstate
Hardness - 4½ to 5
Specific gravity - 6
Cleavage - distinct
two directions
Fracture - uneven, brittle
Heat sensitivity - low

Tetragonal
Colorless, yellow, orange
Refractive index - 1.92
Critical angle - 31½°
Birefringence - .014, medium
Dispersion - medium

Cutting angles:
Culet - 41° Crown - 38°
Cutting lap - fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	100 rpm
vinyl	Linde A	normal
lead	Linde A	normal
pitch	Linde A	normal

Miscellaneous information: Group Two

In spite of being included in Group Two, this material will yield excellent gems with only a reasonable amount of caution. The cleavage is not troublesome, and the brittleness does not show unless the stone is shocked. The lead lap will polish quite well, but scratches are a problem. The tin/lead lap and slow speed will produce a nearly perfect polish.

Fine golden material comes from Mexico. Nice colorless material is found in California, Arizona, and other western states. Pieces up to 20 carats are not unusual; sometimes pieces over 100 carats are available.

SERPENTINE

Magnesium silicate
Hardness - 2½ to 4
Specific gravity - 2.5 to 2.65
Cleavage - none
Fracture - splintery, moderately
tough
Heat sensitivity - none

Monoclinic (never as crystals)
Bluish, greenish, yellowish
Refractive index - 1.55
Critical angle - 40°
Birefringence - weak
Dispersion - none

Cutting angles:
Culet - 43° Crown - 42°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
wax	Linde A	normal

Miscellaneous information:

This material is never truly transparent, but williamsite is nearly so. The slight inclusions make a sleepy gem. It should not be sawed in oil as the material quickly absorbs it. It preforms and laps with relative ease. Polishing is difficult, and the surface tends to furrow and scratch. Rapid movement across the lap during polishing is necessary.

Yellow material comes from New Jersey, and a few other localities. The fine green williamsite comes from Maryland. Good facetable pieces are small, usually under five carats.

SIDERITE

Iron carbonate
Hardness - 3½ to 4
Specific gravity - 3.8
Cleavage - perfect
three directions
Fracture - uneven, brittle
Heat sensitivity - high

Hexagonal
Yellow to greenish
Refractive index - 1.63 and 1.87
Critical angle - 38° (32½°)
Birefringence - .24, very strong
Dispersion - high

Cutting angles:
Culet - 42° Crown - 40°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	50 rpm
wax	Linde A	normal

Miscellaneous information: Group Two

Siderite is a difficult material to handle because of the perfect cleavages. It is best handled at slow speeds in all stages. It preforms with comparative ease on a fine grit wheel in perfect balance. The cleavage and optic axis should be oriented. The best polish is obtained on the metal lap at slow speed.

Siderite is a fairly common mineral, but facetable rough is rare. It is found presently only in Portugal. This material is very clear. Pieces up to 15 carats and larger are known.

SILLIMANITE
(Fibrolite)

Aluminum silicate
Hardness - 6 to 7
Specific gravity - 3.2
Cleavage - very perfect
one direction
Fracture - uneven, crystals are
brittle
Heat sensitivity - low

Orthorhombic
Light sapphire blue
Refractive index - 1.64
Critical angle - 37½°
Birefringence - .019, medium
Dispersion - .019, low

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - micarta or vinyl with
loose grit

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
tin/lead	Linde A	100 rpm

Miscellaneous information:

The hardness of sillimanite is very deceptive, and has no effect on the brittleness. The one cleavage is almost impossible to deal with. Preforming should be dispensed with if possible. Facet cutting should be done at as slow a speed as possible. Polishing is comparatively easy at slow speeds.

Facet quality material comes only from the gem gravels of Burma. The rolled pebbles that have endured the shock of erosion are the best to cut. Pieces are usually small.

SINHALITE

Magnesium iron aluminum borate
Hardness - 6½
Specific gravity - 3.4 to 3.5
Cleavage - none
Fracture - conchoidal, moderately tough
Heat sensitivity - low

Orthorhombic
Brown
Refractive index - 1.69
Critical angle - 36½°
Birefringence - .038, medium
Dispersion - .017, low

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
"lucite"	Linde A	normal

Miscellaneous information:

This is a recently recognized gem mineral, formerly having been thought to be peridot. Its cutting characteristics are not completely known, but it evidently gives very little trouble.

The only known source of faceting material is Ceylon.

SMITHSONITE

Zinc carbonate
Hardness - 5½
Specific gravity - 4.4
Cleavage - perfect three directions
Fracture - uneven, moderately brittle
Heat sensitivity - moderate

Hexagonal
Gray, yellow, blue, green, brown
Refractive index - 1.62 and 1.84
Critical angle - 36°
Birefringence - .230, very strong
Dispersion - low

Cutting angles:
Culet - 41° Crown - 40°
Cutting lap - medium grade of diamond or finer

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	100 rpm
lead	Linde A	normal

Miscellaneous information: Group One

The cleavages of smithsonite do not give trouble during any stage as long as care is exercised. The optic axis should be oriented. Application of dopping heat must be done with care. The best polish is obtained with tin/lead and slow speed.

Fine flawless yellow crystals come from Australia. Yellow and green crystals come from Africa. Most facetable pieces are under ten carats in weight.

SODALITE

Sodium chloro-aluminum silicate
Hardness - 5½ to 6
Specific gravity - 2.24
Cleavage - indistinct
Fracture - uneven, somewhat brittle
Heat sensitivity - low

Isometric
Blue
Refractive index - 1.48
Critical angle - 42½°
Birefringence - none
Dispersion - low

Cutting angles:
Culet - 44° Crown - 43°
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
"lucite"	cerium oxide	normal

Miscellaneous information:
This material is seldom truly transparent. Material comes in large masses suitable for cabochon cutting. Small facetable areas may be found within these masses. The material offers no trouble in cutting or polishing.
Rough comes from Canada, Brazil, and Africa.

SPHALERITE

Zinc sulphide
Hardness - 3½ to 4
Specific gravity - 4
Cleavage - perfect
six directions
Fracture - conchoidal, moderate
Heat sensitivity - low

Isometric
Yellow, red, orange, colorless
Refractive index - 2.39
Critical angle - 25°
Birefringence - none
Dispersion - .156, very high

Cutting angles:
Culet - 40° Crown - 33°
Cutting lap - fine diamond

Polishing:

Lap	Agent	Speed
wax	Linde A	normal
tin/lead	Linde A	35 rpm

Miscellaneous information: Group Two
In spite of the imposing number of cleavage directions, as long as one of them is not parallel to the table, little difficulty is experienced. Sawing may be done if care is exercised. Grinding on a true wheel is no problem. Lapping proceeds rapidly on a fine lap, and polishing is rapid on either lap suggested above. The metal lap gives a perfect polish. The high dispersion produces an unbelievable gem.
Fine red to orange rough comes from Spain. Nice yellow to green material comes from Mexico, Colorado, and New Jersey. Faceting rough from Spain and Mexico in sizes up to 100 carats is usually available; larger pieces up to nearly a pound appear from time to time.

SPHENE

Calcium titano-silicate
Hardness - 5 to 5½
Specific gravity - 3.4
Cleavage - imperfect
Fracture - uneven, tough
Heat sensitivity - none

Monoclinic
Yellow, brown, emerald green
Refractive index - 1.99 to 2.03
Critical angle - 30½°
Birefringence - .134. very strong
Dispersion - .050, high
Twinning - usually contact twins

Cutting angles:
Culet - 41° Crown - 38°
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
lead	Linde A	normal
tin	tin oxide	normal

Miscellaneous information:

This is one of the finest of gems; only the low hardness keeps it from real popularity. The toughness of this material makes it easy to handle during all grinding and facet cutting stages. Most crystals are twinned, with the twinning plane being either a dark band, or a reflective barrier. Orienting the twinning plane parallel to the table will usually correct either situation. This plane is not weak. The optic axis should be oriented, but the crystal shape usually rules against it. Polishing is sometimes a problem as a facet may scratch or furrow; a thin slurry gives the best results.

Fine yellow, brown, and green specimens come from Baja California, Mexico. Brown crystals come from Switzerland. Excellent yellow crystals have come from Brazil. Mexico has produced some huge crystals. These are usually badly flawed, with clean pieces over 25 carats being unusual. The Brazilian crystals are cleaner.

SPINEL

Magnesium aluminum oxide
Hardness - 8
Specific gravity 3.5 to 4.1
Cleavage - imperfect
Fracture - conchoidal, tough
Heat sensitivity - none

Isometric
Colorless, red, blue, green, violet
Refractive index - 1.72
Critical angle - 35½°
Birefringence - none
Dispersion - .02, medium

Cutting angles:
Culet - 41° Crown - 40°
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
typemetal	Linde A	normal

Miscellaneous information:

Spinel is a very easy to handle gem material. Some difficulties may be experienced during polishing. A change of direction, or lap, usually will correct the trouble.

Fine material in the form of water worn pebbles comes from Ceylon and Burma. Nice small crystals come from India. Large pieces are seldom available.

SPODUMENE

Lithium aluminum silicate

Monoclinic

Gem varieties
- Kunzite
- Hiddenite
- Triphane

Color
- Lavender
- Green
- Yellow to colorless

Hardness - 6½ to 7
Specific gravity - 3.2
Cleavage - very perfect two directions
Fracture - subconchoidal, frays easily
Heat sensitivity - moderate

Refractive index - 1.67
Critical angle - 37°
Birefringence - .015, medium
Dispersion - .017, low
Trichroic - light to deep colors

Cutting angles:
Culet - 42° Crown - 40°
Cutting lap - extra fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
tin/lead	tin oxide	normal
tin	tin oxide	normal

Miscellaneous information:

This is a very difficult material to work. Sawing should be done only with a new blade, and very little pressure. None of the varieties of this mineral should be ground on a grinding wheel. A shock during grinding may not show until later. Preform roughly with the trim saw. The table must be oriented a few degrees away from the cleavage plane, and must be nearly at right angles to the deepest color. Facets should be cut on the finest lap possible; never coarser than 800 grit, otherwise corners will fray. Polishing is easy. There is no need to try to finish a gem in one sitting, even though it has been reported that stones will split from strain if left unfinished. Any splitting is due to previous shock, and will happen regardless of the time involved. Many faceters have spent weeks successfully cutting a spodumene gem.

Fine kunzite and hiddenite come from Brazil. Hiddenite comes from North Carolina. Kunzite is found in California. Pieces and crystals are large and run as high as a number of hundred carats.

STIBIOTANTALITE

Tin tantalate
Hardness - 5½
Specific gravity - 6.5 (approx.)
Cleavage - distinct
one direction
Fracture - subconchoidal, brittle
Heat sensitivity - moderate

Orthorhombic
Yellow, brown
Refractive index - 2.3
Critical angle - 25½°
Birefringence - .08, strong
Dispersion - high

Cutting angles:
Culet - 40° Crown - 32°
Cutting lap - fine or extra fine diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
tin	Linde A	normal

Miscellaneous information: Group Two

This is a fairly easy material to handle if proper precautions are taken. The cleavages are not very troublesome. Polishing is fairly easy.

Rough comes from the Himalaya mine, San Diego County, California. It is also reported to come from Madagascar. A very rare material. Clear facetable pieces larger than one carat are difficult to find.

SULFUR

Pure sulfur
Hardness - 1½ to 2½
Specific gravity - 2.05
Cleavage - imperfect
Fracture - conchoidal, very brittle
Heat sensitivity - extreme, melts at 227° F.

Orthorhombic
Yellow
Refractive index - 2.0
Critical angle - 28½°
Birefringence - .28, very strong
Dispersion - weak

Cutting angles:
Culet - 41° Crown - 38°
Cutting lap - wax with Linde A

Polishing:

Lap	Agent	Speed
wax	Linde A	normal

Miscellaneous information: Group Three

Sulfur is an extremely brittle and difficult material to handle. The slightest heat shock will crack the stone. It is too brittle to saw except with a jeweler's saw and kerosene. It may be preformed with a fine cut file or knife. Use water when handling to keep the heat of the hands from cracking the stone. Cut and polish on a very smooth wax lap with Linde A. It must be dopped with a cold dop that is water soluble. Sulfur is soluble in acetone, carbon disulfide, etc.

The best faceting crystals are from Sicily.

TEKTITE

(See Obsidian)

TOPAZ

Aluminum fluo-silicate

Orthorhombic

Gem varieties
- Imperial
- Precious

Color
- Orange, yellow, red
- Blue, colorless, green

Hardness - 8
Specific gravity - 3.5
Cleavage - very perfect one direction
Fracture - conchoidal, tough
Heat sensitivity - none

Refractive index - 1.62
Critical angle - 38°
Birefringence - .008, weak
Dispersion - .014, low

Cutting angles:
- Culet - 42° Crown - 41°
- Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
typemetal	Linde A	normal
tin	Linde A	normal

Miscellaneous information:

The prominent cleavage plane of topaz must be carefully oriented. It must not be less than 10 degrees away from the table, and should not be close to parallel to any other facet. The table orientation is of prime consideration. Orientation for other facets is of lesser concern, but trouble can be experienced in polishing if the facet is close to the cleavage plane. Grinding for preforming is slow because of the hardness and toughness. Facet cutting is fast on a sharp diamond lap; almost any grade is satisfactory. The final lapping should be done on the extra fine lap if possible. Polishing is slow, with the tin/lead lap giving the best polish in the least time. If sensible precautions are used at all times, topaz is not a difficult material to work with.

Nearly all colors of fine material come from Brazil. A nice light tan colored material comes from Mexico. Blue comes from Texas and Colorado. Blue and colorless comes from a number of locations in Africa. A fine sherry colored material from Colorado fades on exposure to light, and the nearly identical colored material from Utah also fades. Imperial topaz is usually available only in crystals and fragments under 10 carats in weight. The tan colored material from Mexico is available in sizes up to 50 carats or more. Other colors may appear in sizes up to a number of ounces.

TOURMALINE

Complex boron aluminum silicate

Hexagonal

Gem varieties
- Achroite
- Dravite
- Verdelite
- Indicolite
- Rubellite
- Schorl

Color
- Colorless
- Brown
- Green
- Blue
- Red to pink
- Black

Hardness - 7 to 7½
Specific gravity - 2.9 to 3.2
Cleavage - poor
Fracture - uneven, brittle
Heat sensitivity - moderate

Refractive index - 1.63
Critical angle - 38°
Birefringence - .02, medium
Dispersion - .017, low
Dichroism - strong

Cutting angles:
- Culet - 42° Crown - 41°
- Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
typemetal	Linde A	normal

Miscellaneous information:

Tourmaline is probably the greatest favorite among faceters. Its colors are numerous, and the varieties of these colors seems endless. The gem is usually easy to cut and polish, and wears well in most types of jewelry. The deep colors must be oriented so that the table of the gem is parallel to the long axis of the crystal. The lighter colors may be oriented in the exact opposite, but there is the possibility of some polarization of light, giving some gems a muddy look. Reasonable care must be exercised in dopping to insure against heat shock. Bi-colored crystals sometimes split at the color juncture. As tourmaline crystals are usually long and slender, this will many times determine the shape of the stone. All rough is not slender and nearly spherical pieces, known as "nodules", are sometimes on the market.

Fine pink to red material comes from Brazil and California. Excellent green crystals come from Brazil and Maine. Madagascar, California, Brazil, Africa, and Mexico produce many other colors. Most facet grade tourmaline is slightly flawed, but this produces gems that look flawless. Absolutely flawless material is unusual, especially in the reds and pinks. Good clean material in sizes up to 25 carats is fairly common. Larger pieces are seen on occasion.

TREMOLITE
(Hexagonite)

Calcium magnesium silicate
Hardness - 5 to 6
Specific gravity - 3.0
Cleavage - very easy
two directions
Fracture - uneven, very brittle
Heat sensitivity - low

Monoclinic
Lavender, colorless
Refractive index - 1.6
Critical angle - 38½°
Birefringence - .02, medium
Dispersion - none

Cutting angles:
Culet - 42° Crown - 40°
Cutting lap - loose grit on vinyl or micarta

Polishing:

Lap	Agent	Speed
"lucite"	cerium oxide	normal
tin/lead	Linde A	100 rpm
vinyl	Linde A	normal

Miscellaneous information: Group One

This material has all the poor characteristics of either Group Two or Three, but has a greater hardness. It frays badly due to the combination of brittleness and cleavages. It may be directionally lapped on an extra fine lap at slow speed. Polishing is slow, but can be helped with a slow lap speed.

Rough (hexagonite) comes from New York. Localities in Canada produce colorless material. Pieces are always small.

VESUVIANITE
(See Idocrase)

VIVIANITE

Iron phosphate
Hardness - 1½ to 2
Specific gravity - 2.6
Cleavage - very easy
one direction
Fracture - splintery, flexible
Heat sensitivity - extreme

Monoclinic
Green, blue-green, purple
Refractive index - 1.58
Critical angle - 39½°
Birefringence - .047, strong
Dispersion - none
Dichroic - green to violet

Cutting angles:
Culet - 43° Crown - 42°
Cutting lap - loose grit on micarta or vinyl

Polishing:

Lap	Agent	Speed
wax	Linde A	normal

Miscellaneous information: Group Three

Saw only with a jeweler's saw and kerosene. Never grind to a preform. Dop with a cold dop, and cover as much of the piece as possible. Orient the cleavage plane parallel to the table. This is an exception to the usual rule. Cut and polish with the cleavage, never against it. Do not attempt to cut the table, any irregularities will polish out. As soon as possible after a facet is cut, polish it, and then cover the polished area with cellulose acetate cement. When polishing the "cleavage plane" table, the crown should be coated with cement. These precautions may keep the cleavage from opening.

Fine rough comes from Idaho, Bolivia, and Africa.

WILLEMITE

Zinc silicate
Hardness - 5½
Specific gravity - 3.8 to 4.1
Cleavage - distinct
two directions
Fracture - conchoidal, somewhat brittle
Heat sensitivity - low

Hexagonal
Green, yellow, reddish
Refractive index - 1.7
Critical angle - 36°
Birefringence - .030, medium
Dispersion - low

Cutting angles:
Culet - 42° Crown - 40°
Cutting lap - medium grade diamond or finer

Polishing:

Lap	Agent	Speed
tin	Linde A	normal
tin/lead	Linde A	normal
"lucite"	cerium oxide	normal

Miscellaneous information: Group One

With reasonable care in handling, the faceter should experience no difficulty with willemite. Most rough is included or flawed.

Faceting material comes only from New Jersey. Pieces are usually small, seldom over ten carats.

WITHERITE

Barium carbonate
Hardness - 3 to 3½
Specific gravity - 4.3
Cleavage - distinct
one direction
Fracture - uneven, somewhat brittle
Heat sensitivity - low

Orthorhombic
Yellow, colorless
Refractive index - 1.6
Critical angle - 38½°
Birefringence - .148, very strong
Dispersion - low
Twinning - crystals always twinned

Cutting angles:
Culet - 42° Crown - 41°
Cutting lap - extra fine diamond, slow speed

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	50 rpm
wax	Linde A	normal

Miscellaneous information: Group Two

This material is seldom transparent. All stages call for reasonable care, but it does not present any great problems. The twinning planes are not of concern, as most of the faceting material is massive. The best polish is with the metal lap and greatly reduced speed.

Faceting material comes from Kentucky, Illinois, and England. Facetable pieces are usually small, with 25 carats being the usual maximum.

WULFENITE

Lead molybdate
Hardness - 2.75 to 3
Specific gravity - 7
Cleavage - distinct
one direction
Fracture - uneven, very brittle
Heat sensitivity - extreme

Tetragonal
Orange, red, brown
Refractive index - 2.3
Critical angle - 25½°
Birefringence - .098, strong
Dispersion - none

Cutting angles:
Culet - 40° Crown - 33°
Cutting lap - loose grit on micarta or vinyl

Polishing:

Lap	Agent	Speed
wax	Linde A	100 rpm
wax	tin oxide	100 rpm
wax	Linde A	normal

Miscellaneous information: Group Three

The brittleness makes this material very difficult to handle. The cleavage is not troublesome. Facet cutting is safest on a wax lap with tripoli or Linde A. Shock must be avoided. Polishing is fast, with a tendency to gall at the upper facet edges.

Rough comes from Arizona, usually in crystals less than one-eighth inch thick.

ZINCITE

Zinc oxide
Hardness - 4 to 4½
Specific gravity - 5.6
Cleavage - perfect
one direction
Fracture - subconchoidal, brittle
Heat sensitivity - low

Hexagonal
Deep red
Refractive index - 2.02
Critical angle - 30°
Birefringence - .016, medium
Dispersion - low

Cutting angles:
Culet - 41° Crown - 36°
Cutting lap - fine or extra fine diamond

Polishing:

Lap	Agent	Speed
wax	Linde A	normal
tin/lead	Linde A	100 rpm

Miscellaneous information: Group One

The brittleness of this material makes it necessary to handle it with extreme care. The cleavage is not troublesome. Lapping should be done only on the extra fine lap. Polishing may be done on metal laps at regular speeds, but scratches are inevitable. Wax at regular speeds yields a good polish. The metal lap at reduced speed is best.

Facetable material comes only from New Jersey. Pieces over three carats are very difficult to find. Gems of zincite lose some of their luster over a period of time. This can usually be restored by careful wiping with a soft tissue.

ZIRCON

Zirconium silicate
Hardness - 7½
Specific gravity - 4.6
Cleavage - imperfect
two directions
Fracture - conchoidal, brittle
Heat sensitivity - none

Tetragonal
Colorless, red, violet, yellow, brown, blue, gold, green or greenish
Refractive index - 1.96 (high type)
(1.79 - low type)
Critical angle - 31°
Birefringence - .06, strong
Dispersion - .038, high

Cutting angles:
Culet - 41° Crown - 38°
Cutting lap - any grade of diamond

Polishing:

Lap	Agent	Speed
tin/lead	Linde A	normal
typemetal	Linde A	normal
tin	Linde A	normal

Miscellaneous information:

Zircon is another very popular gem material. It does not have a great hardness, but the high R.I. and the numerous colors more than compensate for it. Zircon is an interesting mineral in that it appears as two types. The so-called "high" type has the optical properties given above. This material decomposes into what is known as "low" zircon, or more correctly metamict zircon. The former is found in a wide variety of shades from yellow to red, while metamict is found only as green or some shade of green. Metamict is a mixture of zirconium oxide and quartz, the result of the decomposition.

Most facetable zircon is found in Asia, where the "high" type is found only as yellow to red. These are heat treated to produce the fine blue "starlite" and colorless.

Zircon usually offers no difficulty in any stage of faceting, but because it is prone to impurities, as well as decomposition, the lapidary characteristics may vary. Trouble is sometimes encountered with the metamict type.

The best known faceting rough is from Ceylon, Burma, or other Asiatic countries. Canada sometimes produces very small brown pieces. A single location in Africa has produced excellent bright red crystals. Fine large, nearly colorless, pieces come from Australia. Natural browns and reds, and the heated blue and colorless are usually on the market. These are rejects from the native cutters, and are usually under 10 carats in weight. The other colors and types are difficult to find.

ZOISITE

(See Epidote)

Appendix II

Useful Tables

And Formulas

TABLE 17

MACHINE SPEEDS

Diameter of Motor Pulley	Diameter of Machine Pulley in Inches						
	3	4	6	8	10	12	14
1 1/4	715	535	350	265	215	175	150
1 1/2	850	645	425	320	265	215	180
2		860	575	430	345	285	215
2 1/2				540	430	360	310
3				645	515	430	365

Based upon a motor speed of 1725 rpm

To find figures for other machine pulley sizes, halve the revolutions for a pulley half the diameter. As an example: For a 1 1/2 inch motor pulley, a 6 inch machine pulley will produce a speed of 425 rpm (1/2 the speed of the 3 inch pulley).

Below are two formulas for obtaining speeds with pulleys of diameters other than covered by the table above.

$$\frac{\text{Machine Pulley Dia. x Machine rpm Desired}}{\text{Motor rpm}} = \text{Motor Pulley Diameter}$$

$$\frac{\text{Motor Pulley Diameter x Motor rpm}}{\text{Machine rpm Desired}} = \text{Machine Pulley Diameter}$$

TABLE 18

WEIGHTS AND MEASURES

Weights - Metric to Avoirdupois and Troy

1 grain Av. = 1 grain Troy

1 point = 1/100 carat = .030 grains

1 carat = 100 points = 3.08 grains

5 carats = 1 gram = 15.43 grains

141.7 carats = 1 oz. Av. = 28.349 grams

2267.9 carats = 1 lb. Av. = 453.6 grams

7.75 carats = 1 dwt. Troy = 1.55 grams

155.5 carats = 1 oz. Troy = 31.1 grams

1866.0 carats = 1 lb. Troy = 373.2 grams

Measure - Metric to U. S. inches

1 micron = 1/1000 mm = 1/25,400 inch

1 mm = 1000 microns = 1/25 inch

10 mm = 1 centimeter = .39 inch

25.4001 mm = 1 inch = 2.54 centimeters

Liquid Measure - Metric to U. S. System

1 cubic centimeter (cc) = 16.2311 minims

100 cc = 3.381 fl. ounces (oz.)

1 pint = 473.1cc = .473 liter

1 quart = 946.3 cc = .946 liter

1 gallon = 3.78 liters

TABLE 19

CRITICAL ANGLE

Table 8 gives the critical angles in whole degrees, which should be sufficient for most purposes. For those that need greater accuracy, the formula below is offered.

When r equals the critical angle, and n equals the RI: $\sin r = \frac{1}{n}$

To use this formula, it is necessary to have a table of natural trigonometric functions. As an example: the RI of tourmaline is 1.63.

Dividing = .6136. Further, .6136 is the natural function of $37^{\circ}51'$, the critical angle for tourmaline.

TABLE 20

DOPPING SHELLAC

In a small jar with a tight-fitting lid, place a small amount of orange flake shellac. Cover with alcohol and let stand 8 to 24 hours. Add more alcohol to the desired consistency which should be about like thin cream. More alcohol may need to be added at intervals during use.

Flake shellac can be purchased from lapidary and jewelry supply houses. A quarter pound will be sufficient for a number of years. Ordinary denatured alcohol is satisfactory, but duplicating fluid, obtainable at stationery stores, seems better.

Orange gasket shellac, available at automotive supply stores, is also usable.

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Glossary

Abrasives - Hard substances used for abrading or cutting away of surfaces. The commonest are: diamond (pure carbon), carborundum (silicon carbide), and powdered corundum (aluminum oxide).

Acetylene tetrabromide - (Tetrabromoethane) A liquid of high refractive index (1.63) and high specific gravity (2.95), valuable in determining gem species. See Table 11.

Adamantine - The type of luster typical of diamond and other very high refractive index gems. The name is derived from adamas (unconquerable), an old name for diamond.

Aggregation and Flow - A behaviorism of polishing agents where the particles gather and act as a single piece of grit.

Aligning Pin - A device on a redopping fixture that facilitates the perfect alignment of a preform.

Amorphous - Any mineral without any regular geometric form. Characterized by having the same internal structure in all directions.

Angle Stop - A device on a faceting machine that stops cutting at a predetermined protractor angle.

Angle of Inclination - The angle, away from normal, of a ray of light striking a surface.

Anisotropic - The minerals crystallizing in the tetragonal, hexagonal, orthorhombic, monoclinic, and triclinic crystal systems. Many of these exhibit double refraction by breaking light into rays that travel at different velocities.

Apex - The upper point of a rose cut or briolette cut, or any other cut without a table.

Baguette Cut - A rectangular step cut.

Beilby Layer - A thin layer on the surface of some polished materials that is the result of the flow of molecules induced by heat during polishing. See Page 219.

Biaxial - The property of some crystals (orthorhombic, monoclinic, and triclinic) to split light into two directions of single refraction.

Birefringence - Double refraction. The amount is measured by the difference in refractive index between the two rays.

Boart, Boort, Bortz - The name used for diamond powder used as an abrasive.

Boule - The drop-shaped "crystal" of synthetic spinel and corundum produced in the Verneuil (gas) furnace.

Break Facets - The facets that border the girdle of a faceted gem. They are sometimes known as the cross or skill facets.

Brilliant - Usually a round gem. A gem that shows brilliance.

Brilliant Cut - The term used for the round faceted cuts. It is usually associated with the standard brilliant and its close modifications.

Briolette - A drop-shaped stone having no table.

Brittleness - The tendency of a mineral to break easily.

Bromoform - A liquid of relatively high refractive index (1.59) and a high specific gravity (2.9). See Table 11.

Cabochon - The style of gem that exhibits a dome-shaped top.

Carat - The unit of weight used for gems. One-fifth of a gram.
Carbon Disulfide - A liquid of high refractive index (1.63). See Table 11.
Carborundum - The trade name for silicon carbide, a product of the electric furnace. Hardness 9 1/4.
Cerium Oxide - One of the polishing agents used with gems.
Cheat - The amount of deviation from normal (to right or left) when using a cheater on a faceting machine.
Cheater - A device on a faceting machine that allows the quill (and stone) to rotate to either right or left of the normal index setting. This device is invaluable in polishing a stone.
Chemical Composition - The makeup of a molecule of any substance. Usually two or more atoms combining under certain laws.
Cinnamon Oil - (Cassia Oil) A liquid used in immersion of gems to find flaws. See Table 11.
Cleavage - The tendency of certain crystals to break along certain directions. This breaking produces very flat surfaces.
Color Zone - A band or spot of color that is deeper in relation to that of the surrounding material.
Conchoidal Fracture - The curved (sea shell-like) surface produced upon breaking certain minerals.
Concentric Scoring - The introduction of pits and scratches on a polishing lap, in a manner that they lie in rings around the center of the lap.
Contamination - Any unwanted particle on a cutting or polishing lap that is larger or harder than desired.
Critical Angle - (Critical Angle of Total Reflection) The angle at which a ray of light, traveling from one medium into one of another density, will reflect off from the surface that it strikes. If the ray is incident at less than the critical angle, it will enter the second medium; if incident at greater than the critical angle, it will reflect back into the first medium.
Crown - The portion of a faceted gem above the girdle.
Crystal - A solid that is surrounded by flat surfaces that follow certain definite and invariable laws. The flat surfaces are known as crystal faces.
Crystal Axis - (Crystalographic Axis) An imaginary line drawn between crystal faces through a crystal. Three or four of these axes intersect in the exact center of the crystal.
Crystal Systems - Six geometric forms. All natural and synthetic crystals form in one of these six systems.
Crystal Lattice - The arrangement of molecules within a crystal. See Figure 2.
Cube - A figure made of six equal squares arranged to form an equidimensional box. The simplest form of the isometric crystal system.
Culet - The lower tip of a faceted gem. It may be a sharp point or a chisel-like edge. On professionally cut gems a facet is sometimes placed at this point. This is known as the culet facet.
Culet Angle - The angle (in relation to the girdle) of the facets that reach the culet of a gem.
Cumulative Error - Discrepancies in the meeting of facets that are the result of small errors made at different stages.

Diamond Dust - See Boart.
Diamond Powder - See Boart.
Diamond Saw Blade - A metal disc having its rim impregnated with boart, used in sawing gem materials.
Diamond Shape - A facet cut with acutely pointed, triangular ends.
Diamond Tongs - An instrument used to handle faceted gems. See Figure 114.

Dichroism - The property of a mineral to show two different colors, or color shades, through two different directions of the crystal. See Figure 49.
Directional Cutting and Polishing - The placing of a stone on the correct position on a lap, so that the lap is turning in a direction (in relation to the stone) that is dictated by the cleavage of the material being cut.
Dispersion - The property of a mineral to break ordinary daylight into the spectral colors.
Dop - A stick or rod to which is attached a piece of gem material, to facilitate the cutting process.
Dopping Wax - A hard wax-like substance used to cement a stone to a dop stick.
Double Refraction - The result of the property of a mineral to break light into two or more rays. Birefringence.
Double Rose - The name of the type of cut consisting of two rose cuts placed back to back.
Doublet - A gem made of two halves cemented together, usually at the girdle.

Elements - The substances which combine in many ways to form all natural articles on earth. See Table 1.
Emerald Cut - The name used for a rectangular (with truncated corners) cut. It was evidently developed especially with the emerald in mind.
Emergent Ray - A ray of light moving from a medium of greater density to a medium of lesser density.
Ethylene Bromide - A liquid of medium Refractive index (1.53) and high specific gravity (2.17). See Table 11.

Fabulite - The trade name for gems of strontium titanate.
Facet - The small flat faces placed upon a faceted gem.
Faceted Girdle - A girdle made up of narrow facets completely surrounding a faceted gem.
Faceter - One who produces faceted gems.
Faceting Head - Another name for a faceting machine.
Fancy Shapes - The name sometimes applied to faceted stones of unusual shapes and outlines.
Feathers - Layers of inclusions in gemstones, usually many small cavities that have a feather-like or veil-like look.
Fire - The name given to flashes of color seen in a gem with strong dispersion.
Flaws - Any unwanted inclusions within a gemstone. The strictest definition would be actual cracks.
Flexible - A characteristic of some minerals in which they can be bent without breaking.
Fracture - The name applied to a freshly broken surface of a mineral. Sometimes applied to a crack within a gemstone.
Freeform Gem - A gem that has an unsymmetrical outline. See Figure 64.

Gem - A mineral cut and polished to a predetermined shape.
Gemstone - A term applied to material that has the potential of becoming a gem.
Girdle - The outer edge of a gem. It forms the line of junction between the pavilion (lower portion) and the crown (upper portion) of a gem.
Glycerine - A liquid used in RI and specific gravity determinations. Table 11.
Goniometer - An instrument for measuring angles between faces of a solid.
Gram - The unit of weight of the metric system. One gram equals five carats.
Grinding Wheel - A wheel made of silicon carbide, used to grind gem materials.
Grit - A name applied to abrasive materials in general. These are sometimes designated in grades or sizes, known as grit sizes.

Ground Girdle - An unfaceted girdle of a faceted gem.

Hand Charged Copper Lap - A disc of copper or bronze into which a charge of diamond boart is introduced by hand methods. See Figure 18.
Hardness - The ability of a mineral to resist scratching.
Heat Shock - The result of raising the temperature of a mineral too rapidly. It usually results in fractures.
Heat Treatment - A carefully controlled process of applying heat to gem materials in order to change the color.
Heavy Liquids - Liquids of high specific gravity used to determine the specific gravity of minerals. See Table 11.
Hexagonal - One of the crystal systems. See Figure 4.

Immersion Liquids - Certain liquids of high RI used to immerse gems in order to find flaws. See Table 11.
Impact - A hard blow placed upon a mineral or gem.
Incident Ray - A ray of light moving in a medium of one density, striking the surface of another medium with greater density.
Inclusions - The general term used to describe any foreign material in a gem material. These are usually small in relation to the bulk of the piece of material.
Index - The portion of a faceting machine that is gear-like.
Index of Refraction - See refractive index.
Isometric - (Cubic) One of the crystal systems. See Figure 3.
Isotropic - The isometric and amorphous minerals in which light travels in only one speed in any direction within the substance.

Jamb-peg - The name applied to the primitive faceting machine. See Figure 7.

Lap - The name applied to flat discs or wheels used in gem cutting. Some are made for cutting gems, others for polishing. A lap is used only on the flat surface.
Lapidary - The name applied to craftsmen that cut and polish gems.
Linde A - The trade name for a polishing agent made of very finely ground synthetic corundum.
Loose Grit - Abrasive grit applied to a lap without being embedded.
Low Zircon - The name applied to zircon with a low refractive index (about 1.80). It is usually of a green color and nearly amorphous.
Lubrication of Cutting Lap - Application of water or other coolant to a lap, in order to facilitate facet cutting.
Luster - The character of light reflected from a mineral surface. It is the result of the physical and optical conditions of the surface. See Table 5.

Marquise Cut - The name given to a cut which is pointed at two ends, with the sides being portions of a circle.
Medium - A transparent substance that will allow light to travel through it.
Metamict - A term applied to material that has had an internal chemical breakdown. This is the case with low zircon, and the name is often applied to it.
Methylene Iodide - A liquid of high specific gravity (3.33) and high RI (1.740) used as a specific gravity and immersion liquid. See Table 11.
Metric Carat - A unit of weight used for gems. It is one-fifth of a metric gram.
Micron - The unit of measurement for very small sizes. It is one-thousandth (1/1000) of a millimeter. See Appendix II.
Millimeter - A unit of measurement for medium sizes. It is one-thousandth of

a meter. A meter is approximately 39 inches. One inch is approximately 25 millimeters.

Mineral - (Mineral Species) An inorganic substance, formed naturally, having a crystalline and chemical structure, and certain physical and optical properties that are reasonably constant.

Mohs Scale of Hardness - A scale for measuring the hardness of minerals. See Table 4.

Molecule - A group of two or more atoms tied together by electrical bonds. The smallest particle of a mineral (and other substances) that can exist on its own.

Monoclinic - One of the crystal systems. See Figure 5.

Multifacet Cuts - A group of round cuts with a greatly increased number of facets.

Needles - A loosely used term to describe slender crystals enclosed in a mineral.

Normal - An imaginary line drawn at 90° (right angles) to a surface being struck by light rays.

Obus - The name given to a rectangular step cut gem with one pointed end.

Octahedron - A crystal form bounded by eight faces, each of which is an equilateral triangle. See Figure 38.

Opaque - A material that will allow no penetration of light.

Optic Axis - The one direction in an anisotropic mineral through which a light ray shows single refraction.

Optical Properties - The effects of a gem material upon light that may pass through it.

Orientation - The aligning of two portions or features to a certain relationship. That is placing a cleavage plane at a definite number of degrees away from parallel to the table.

Orthorhombic - One of the crystal systems. See Figure 5.

Overcutting - The act of cutting a facet larger or deeper than the corresponding facets on the same stone.

Oxides - A group of minerals consisting of a combination of a metal and oxygen.

Parting - (Parting Plane) A direction of weakness in certain minerals, apparent along certain twinning planes. For the faceter it is virtually identical to cleavage.

Pavilion - The lower half of a faceted gem.

Pavilion Facets - The facets that cover the pavilion of a faceted gem.

Pendeloque Cut - A drop-shaped gem possessing a table.

Permanently Charged Lap - Cutting laps that are manufactured. These laps hold their charge much longer than the usual copper lap.

Physical Properties - The characteristics of a mineral, such as hardness, specific gravity, toughness, etc.

Pleochroism - The property of some anisotropic minerals to show more than one color or color hues through different directions of the mineral.

Point - A unit of weight of gems, one-hundreth (1/100) carat.

Polish - The lustrous surface induced on gems.

Polishing Agent - A powder used on a polishing lap to polish gems.

Polishing Lap - A flat disc used with a polishing agent to polish gems.

Portuguese Cut - The most popular of the multifacet brilliants.

Preform - A somewhat roughly ground piece of gem material that closely resembles the final size and shape of the gem.

Pseudomorph - A mineral taking the form of another, either by substitution or by alteration.

Quill - The name used for the part of the faceting machine that holds the dop.

Radial Scoring - Grooves or pits introduced along the radius of a polishing lap.
Recharging a Lap - The act of embedding more boart in a lap.
Redopping - The transferring of a half-completed stone to another dop.
Redopping Fixture - A tool used for redopping a stone.
Reflection of Light - The behaviorism of light when it strikes a surface it cannot enter. The reflected ray always leaves the surface at exactly the same angle (on the other side of normal) as it approached.
Refraction - The bending of a light ray as it passes from a medium of one density into a medium of another density.
Refractive Index - The number attached to the ability of a material to bend light upon entry into it. Sometimes written as RI. The refractive index number is based upon air as 1.0.
Refractometer - An instrument for measuring the refractive index of gems.
Resurfacing a Polishing Lap - The act of smoothing grooves, etc., worn into a lap by use. This is best done on a lathe.
Rose Cut - The name given to a facet cut consisting of a crown with no table, and without a pavilion. Two roses, back to back, is known as a double rose.
Rough - Faceting material on which no work other than sawing has been done.
Rutilated Quartz - Colorless, citrine, or smoky quartz containing needle-like crystals of rutile. It is sometimes faceted into interesting gems.

Scintillation - The ability of a gem to apparently create more rays of light than entered it. This is accomplished by placing numerous facets on the gem.
Scoring - The placing of pits or scratches on the surface of a polishing lap.
Sectile - The property of a mineral to produce a shaving when cut with a knife.
Shellac - A viscous liquid placed upon a preform to enable dopping wax to better adhere. See Table 20, page 316.
Shock - A sharp blow or sudden temperature rise to which a gem material may be subjected. It sometimes results in fracturing.
Silicates - A group of minerals that are a combination of silicon and oxygen, and one or more metals. This group contains most of the well-known gems.
Slurry - A mixture of polishing agent and a liquid (usually water) that is applied to a polishing lap.
Soft Mineral - For purposes here, any mineral under 5 in hardness that may be cut into a gem.
Soudé Emerald - A stone made to resemble an emerald. It is made of two pieces of clear material, with a green color band at the girdle.
Specific Gravity - The weight of a substance in relation to an equal volume of water. Water equals 1.
Speed of Light - In air, it is approximately 186,000 miles per second. The speed of light in any transparent substance may be found by dividing 186,000 by the RI of the material.
Star Facet - The small facets that surround the table of a faceted gem.
Step Cuts - The group of faceted cuts that are characterized by having fairly long and narrow facets on both pavilion and crown.
Suite of Colors - A group of gems of a single species, each a different color or color hue.
Symmetry - Anything that has symmetry is capable of being divided into two or

more parts, each of which is identical to the other.

Table - The large facet on the top of most faceted gems. It usually lies parallel to the girdle.
Table Cut - One of the early facet cuts produced from the octahedron by adding a table, and polishing the existing crystal faces. See Figure 60.
Tablet Cut - A faceted cut using two tables and two sets of crown facets to produce a thin gem.
Tetragonal - One of the crystal systems. See Figure 4.
Three-phase Inclusions - Small cavities in a mineral filled with a liquid, a gas, and a solid. See Figure 33.
Tin Oxide - One of the polishing agents used with gems.
Titania - The trade name used for gems of synthetic rutile.
Toluol - (Toluene) One of the hydrocarbon liquids used to dilute certain heavy liquids, such as methylene iodide.
Total Reflection - The phenomenon where a ray of light enters a medium (usually a gem) and is reflected within so that it leaves at nearly the same angle and plane as it entered.
Toughness - The ability of a mineral to resist breaking.
Transparent - A substance with or without color that will transmit light.
Transposition Chart - A diagram used to facilitate the cutting of a faceted stone with an index device other than is suggested on the cutting diagram.
Trap Cut - An old name applied to what is now the step cut. The word trap is a Dutch word for staircase.
Trichroism - The ability of a mineral crystal to transmit three different colors, or shades of colors, through three different directions.
Triclinic - One of the crystal systems. See Figure 5.
Trim Saw - A mechanical device used to saw through minerals. For faceting the saw blade is usually quite thin.
Triplet - A composite gem made of three pieces.
Truncate - Having an obtuse end, cut at right angles to its length.
Twin Crystal - A crystal in which two or more individuals have grown together according to certain laws.

Undercut - A facet that has not been cut to the same depth as others of the same type on the same stone.
Uniaxial - The name for the group of minerals with double refraction, that have one direction of single refraction.

Veils - Layers of very small cavities in gem materials. These layers, having a feather-like look, are sometimes so small as to be barely discernible with the naked eye. The cavities are usually filled with a liquid or liquids, with or without bubbles of gas. See Figures 26 and 33.

Wavelength - The distance between two crests (or troughs) of successive waves such as in water, electricity, etc. The term is of interest to faceters in relation to light rays. See Figure 40.
White Light - Ordinary sunlight which consists of all spectral colors, and all wavelengths.

Xylol - (Xylene) A liquid hydrocarbon used to dilute RI and specific gravity liquids.

Zone of Color - A band or spot of deep color in a gem material.

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